# IMPACTS OF CLIMATE CHANGE ON FOOD SECURITY IN NOTHERN TANZANIA: A CASE OF MONDULI DISTRICT

**SCARION ANATORY RUPIA**

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## CERTIFICATION

The undersigned certifies that he has read and hereby recommended for acceptance by Open University of Tanzania, a Dissertation titled: Impacts of Climate Change on Food Security in Northern Tanzania: A Case of Monduli District, in partial fulfillment of the requirements for the Degree of Master of Arts in Monitoring and Evaluation.

……..

Dr. Reguli Mushy

Supervisor

…….

Date

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Date

## DEDICATION

I dedicate this work to my Fiancee Anna Nyahonyo, my Boom Boom family, Shirley Rush, Andrew Mabbry, Jasson Johnson, Yang Yang Zhou, Frank Wertheim, Paul Johnson, Daniel Mlangwa, Gideon Tanditse, Pilly Omary, Mwenge Godlaid, and Guthrie for all the support they showed me. Without their love and sacrifices made towards the fulfillment of my education I would not be who I am today.

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## ABSTRACT

Climate change has marked tragic effects across the world. It is now one of pressing challenges to food security specifically in developing countries such as sub-Saharan, about 80% of population in Tanzania depends on agriculture which contributes 24% of the GDP. Due to the changes in climate, food security status keeps declining resulting to decline in number of meals at a household. This cross sectional study examined the impact of climate change on food security in northern Tanzania through three main objectives which were; trends of rainfall and temperature as evidence of climate change, trends in food security (access, use and availability) as a function of normalized income and perceptions on seasonal changes and its effect on food security in the study area. Quantitative and qualitative research approaches were applied and simple random sampling technique was used obtain respondents to collect data from a sample of 362 households where as purposive sampling obtained 12 key informants. Findings showed that the amount of rainfall has been declining linearly suggesting that the area has decreasing amount of rainfall as time goes. The study shows linear increase in both maximum and minimum temperature; whereas minimum temperature is increasing at high rate than maximum temperature of the year as a sign of global warming. Majority of households face decline in food access with no ability to buy food resulting to decline in number of meals per day at households. Finally, the study recommends for establishment of collaboration between local extension and livestock officers, climatological departments to extend services and information to local level

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## LIST OF ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| ADF | African Development Bank |
| CCFS | climate change and food security |
| FAO | Food and Agriculture organization of the United Nations |
| GDP | Gross Domestic Product |
| IPCC | Intergovernmental Panel on Climate Change |
| NBS | National Bureau of statistics |
| NFU | National Farmers Union |
| NRCB | the Natural Resources Conservation Board |
| SPSS | Statistical Software for Social Science |
| TMA | Tanzania Meteorological Agency |
| UN | United Nations |
| URT | United Republic of Tanzania |
| WMO | World Meteorological Organizatio |

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background to the Problem

The changing climate of earth is a critical issue, raising the risk of major global environmental, social and economic disturbances. Though natural sources of climate change such as volcanic eruptions, orbital shifts, variations in solar radiation and crustal plate movement have been important, multiple lines of evidence indicate that human influences such as the combustion of fossil fuels, primarily coal, oil, and natural gas, with additional contributions from deforestation, land use changes, soil erosion, and agriculture have an increasingly dominant impact on climate change since the mid-twentieth century. Although the magnitudes of future effects are uncertain, human influences on the climate are growing. The potential consequences of climate change are great, and the actions taken over the next few decades will determine human influences on the climate for centuries (Dasgupta, 2015).

The expected future climate in the tropics is higher temperatures and decreasing rainfall patterns, as well as increasing frequency of extreme climate events such as droughts and floods (IPCC, 2007). In addition, numerous long-term climate changes have been realistic at continental, regional and ocean basin scales. These include changes in Arctic temperatures and ice melting, widespread changes in precipitation levels, salinity in the ocean, wind patterns and intense weather aspects including droughts, heavy precipitation, heat waves and tropical cyclone strength (IPCC, 2007)

Temperature changes and rainfall associated with ongoing greenhouse gas emissions continue to bring changes in land suitability and crop yields. The primary concern

about climatic change and food security is that shifting climatic conditions can trigger a vicious circle where infectious disease causes hunger, making the affected population more vulnerable to infectious diseases. Fundamentally all climate change factors, including drought, higher temperatures or heavy rainfall, influence the risk of the disease and there is considerable evidence that these changes impact food security (Schmidhuber *et al*., 2007).

At a global level, people with moderate food insecurity are faced with uncertainties about their ability to obtain food and have been forced to adjust the quality and/or quantity of food they eat due to financial problems or other resources at times during the year. It therefore refers to a lack of consistent access to food, which reduces dietary consistency, disrupts regular eating habits, and may have negative nutritional, health and well-being effects. People facing severe food insecurity, on the other hand, are likely to have shortage of food, have hunger and, at the extreme, have gone without food for days, putting their health at risk (FAO, 2018).

Climate change is already undermining global efforts to eradicate hunger due to extreme climate change such as weather events, land degradation and desertification, water scarcity and rising sea levels. Overall, for the third year in a row in 2017, the number of hungry people increased to a total of 821 million worldwide. If countries fail to address climate change and build resilience to its inevitable impacts, this number will continue to increase (FAO, 2018). Since the early 1990s, the number of extreme climate-related disasters, including extreme heat, droughts, floods and storms, has doubled with an average of 213 of these occurring annually during the 1990–2016 period (FAO, 2019).

Such disasters damage the agricultural productivity of major crops such as wheat, rice and maize, resulting in higher food prices and losses of income that reduce access to food for people. FAO shows further evidence of this trend, demonstrating that prevalence and number of undernourished people tend to be higher in countries that are highly exposed to extreme climate conditions. Under-nutrition is again higher when exposure to extreme climate is mainly caused by a high percentage of the population depending on farming systems that are highly sensitive to undependable rainfall and temperature (FAO, 2019).

The effects of climate change have already been observed, according to the Intergovernmental Panel on Climate Change (IPCC, 2007), and scientific findings indicate the need for preventive and swift action. Climate change will influence Africa in different ways. For example, predictable climate change impacts in Africa by 2100 could include increases from 1.0C to 4.7 ° C in low rainfall temperatures by 2%-25%, increased evapo-transpiration by up to 132%, and reduced run-off by up to 50% (Magadza, 1996; Hulme, 1996).

Regional habitats provide many of the world's poor with the main source of livelihood. Most rural poor people in sub-Saharan Africa depend on highly climate-sensitive rain-fed subsistence or small-scale agriculture, pastoral herding and direct harvesting of ecosystem services such as forests and wetlands IPCC, 2001 for their livelihood and food security. The productivity of this livelihood base is highly vulnerable to climatic stresses such as temperature changes, precipitation (both quantity and variability) and increased droughts and flood frequencies. The vulnerability of most poor people in Africa to climate stress is compounded by

rampant poverty, HIV / AIDS, lack of adequate access to services such as land and water and management capability, income (IPCC, 2001).

Farming depends almost entirely on rainy season efficiency in most African countries, as well as in Tanzania (IPCC, 2007). This makes Africa particularly vulnerable to climate change / variability. Nevertheless, climate change is seen as posing the greatest threat to agriculture and food security in the 21st century, mostly in several poor and agricultural sub-Saharan African countries (SSA) with low capacity to cope (IPCC, 2007; FAO & UN, 2008). Review of current environmental and economic developments in Africa shows a growing struggle for access to and use of freshwater resources. (IPCC, 2007).

There has been an increase in the number of extreme warm temperatures in many regions of the world, an increase in the frequency of heavy precipitation events, and high sea levels. The warming is amplified by natural feedback in the system (IPCC, 2012).

> *Climate change affects all four parameters of food security: availability of food, accessibility, utilization and stability of the food system, which in return has an impact on human health, livelihood assets, food production and distribution channels, and changes in buying power and market flows (FAO, 1996).*

A normal pastoral family obtains food like milk, meat from livestock and sells such livestock to buy food. Income generated from selling livestock is often used to contribute to school fees and other educational inputs as well as healthcare. Agriculture is particularly vulnerable to climate change as it mostly relies on rainfall. Some findings include low food production, reduced rangeland areas, overgrazing

and disputes in land use. Tanzania has a high potential base for agriculture development, however agricultural production is low (Kimaro, 2018).

### 1.2 Statement of the Research Problem

Tanzania has been greatly affected by climate change especially on food and livestock interface. The livelihood of the Monduli community is largely dependent on livestock farming. They also have found themselves in trouble due prolonging drought seasons that results into scarcity of grazing land. According to the Global Acute Malnutrition based on MUAC scale measures by WHO, Monduli district with its significant number of households has minimal adequate food consumption. The MUAC measure prevail between 5%-9% which means that the area is at risk of food insecurity (URT, 2017).

Pastoral communities of northern Tanzania have experienced nonlinear rainfall and temperature trend for 30 years (Theodory *et al*., 2014). Climate change has given rise to extreme drought, severe water and shortage of signature. Some people in the community practice both farming and livestock keeping. With the current climate change, livestock production, survival and distribution are more affected by reduced rangeland quantities and quality and the prevalence of vector-born animal diseases. (Shemsanga *et al.*, 2010).

Lack of rainfall in many parts of Monduli communities in has caused disappearance of pastures and water which are the potentials need for sustainability of livestock. Drought cause livestock to become weak as the result they produce unhealthy milk, meat and then the market become less (Saringe, 2011). Not only for livestock but

also Farmers in Monduli District are predominantly small-scale, subsistence farmers. The average number of acres under cultivation by household in Monduli district is 1.02. Maize is the most commonly grown crop among households cultivating land in Monduli. Other commonly grown crops include beans banana, rice, and tomatoes.

Based on monthly food security in Monduli district; 63% of households worries about food throughout where as 57% eat limited variety of food throughout and only 28% goes to bed hungry in a month. High incidence of children under five malnutrition also exists due to lack and no access for variety of nutritional food (Hartwig *et al*, 2010). Due to such incidence, various interventions have been implemented to adapt to climate change such as initiatives to network groups of farmers and provide them with new climate adaptive measures of food security such as introducing poultry projects, short season crops and those that can also withstand with rainfall shortage like sunflowers, increase access to local extension officers from government and non-government organizations and in Monduli District (Hartwig *et al*., 2010).

However, the approaches have not been able to sufficiently sustain food security in the area due to the fact that the main activity of the community in Monduli is cattle husbandly followed by farming. As farming is growing to accommodate food security but still there is a need to assess more information for the area and the public to be well familiar with, trends of climate change factors and food security so as to enable policies to have a big picture when planning for interventions that will support food security in Monduli district.

Various studies have been done on possibilities of climate change adaptation (Shemsanga, et al., 2010). Governmental policy have been implemented on climate change adaptation. However, livestock keeping in Maasai community remains the primary major activity. As it shows researchers have been able to build knowledge about this place on its climate change and adaptation measures which have much focused only on pastoralists, but the focus on food production has been under looked without considering it as the major source of food security in the community. Therefore, this study aimed to assess how changes in the nature of climate has an impact on food security in Monduli district in Tanzania.

## 1.3 Study Objectives

### 1.3.1 General study Objective

This study aimed at assessing the impact of climate change on food security in Monduli district, Tanzania.

### 1.3.2 Specific Objectives

i. To examine the trends of rainfall and temperature as evidence of climate change in Monduli district
ii. To examine the trends in food security (access, use and availability) as a function of normalized income
iii. To examine perceptions on seasonal changes and its effect on food security in Monduli district

## 1.4 Research Questions

Specifically, the study examined the three outcomes measured at Monduli district;

i. What are the trends of rainfall and temperature in Monduli district?

ii. What is the trend of food security at household level?

iii. How does a seasonal change affect your food security?

### 1.5 Significance of the Study

As the impact of climate change world widely is experience in different ways, the study will add more knowledge on how the food security is affected by climate change especially in the semi-desert and arid areas. Also the study will add more knowledge on the relationship between climate change factors and food security. The study would help climate change policy in addressing climate change threats to allow the most vulnerable to engage in determining what actions to take to improve their resilience. Knowledge is also a key resource in decision-making, particularly in the context of climate change where there is high uncertainty, to improve the quality of knowledge and its use.

### 1.6 Limitation of the Study

i. The researcher had faced few limitations which high expense on climate data from Tanzania Meteorological Agency (TMA) are which delayed for amount two months. Despite of this research being academic, still the researcher was obliged to pay cost sharing for data with TMA. Because of determination and being curious to explore new insights about climate change impact, the research paid for the data.

ii. Unfamiliarity with local language (Maasai) that had to employ two intellectual research assistants

iii. Refusals for consent and lack of time for administrative officials and senior elders to take individual interviews, this made a researcher spend long time to

finish key informant interviews. This was also a challenge to senior women to be interviewed alone as their siblings and spouses doubted privacy talk with a researcher.

### 1.7 Organization of the Study

The study is organized in to five main chapters that is; the first chapter gives an introduction to the study. Here introduces the background to the problem, statement of the research problem, study objectives, research questions that have been examined, significance of the study and limitation of the study. The second chapter of the study presents conceptualization of key terms for the study, followed by theoretical concepts on climate change and food security, empirical reviews, the research gap and conceptual framework of food security and climate change.

Chapter three presents methodology the third chapter presents the research methodology. In this chapter the research design, target population, sampling procedures, data collection procedures, research instruments and data analysis techniques were reviewed. Chapter four deals with finding and discussion from data data analysis, in line with the study objectives. And chapter fiver is conclusion of the summary of findings that gives conclusions and recommendation.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Introduction

This Chapter presents review of the literature that highlights impacts of climate change on food security through trends of rainfall and temperature, food security in three pillars of access, use and availability of food, seasonal changes and its effect on food security. With vivid supportive empirical and conceptual concepts on climate change and food security the chapter identifies the gap that has not been well covered by other researchers, hence this gap the researcher worked on it in the study.

The purpose of this review was to explore existing literature as pertains to the climate change; globally, at continental level, regional and country level. The review also explores the associations between changes in climate, and status of food security at household with focus on how climatic factors impact unfavorably the food security situation of households. The review also focuses on the food security situation in Monduli as well as existing empirical studies in the field. Climate data are observed and maintained worldwide. Climate patterns are generally stable for extended periods of time. Recently (state timeframe), climate events have notably changed, causing scientific experts and pundits to speculate regarding the nature of these changes. Increasing evidence of climate change (variation, intensity, frequency) exists worldwide, regardless of the cause.

Because the people in the Monduli region are reliant on the forces of nature for vegetation to feed both their families and their livestock, any change in climate factors may result in catastrophic consequences. For this reason, the author has

chosen to evaluate the influence of climate change on food security in Northern Tanzania.

## 2.2 Conceptualization of Key Terms

### 2.2.1 Climate

Climate is a place's average environment, generally calculated as a statistical summary of the climate system in terms of the mean and unpredictability of the related quantities over a period of months to thousands or millions of years. As defined by the world meteorological organization, the classical period for averaging these variables is 30 years.The most commonly applicable quantities are surface variables such as temperature, precipitation and wind(IPCC, 2012). Meteorologists quantify daily weather phenomena such as climate, temperature, prec ipitation such as rain, sleet, snow and hail, atmospheric pressure, humidity, wind; (WMO, UNEP and UNESCO, 2005).

### 2.2.2 Climate Change

Climate change refers to any significant long-term change in the expected patterns of average weather of a region or the whole Earth over a significant period, it is about an abnormal variation to the climate and the effects of such variations on the parts of the earth. Climate change variables are described in the mean state and other statistics, such as standard deviations, the occurrence of extremes of the climate on all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing external

variability (IPCC, 2007). It denotes the deviation of climate statistics over given period such as month, season or a year from long term climate statistics in relations to the corresponding calendar period, climate change is often measured regularly using anomalies (WMO, 2005).

Rainfall and water resources in Africa show high levels of variability across different locations with negative consequences for communities' livelihoods in this area. Climate change is characterized by changes in weather leading to warmer temperatures, shifts in rainfall patterns and increased frequency and perhaps extreme weather intensity (Wheeleret, 2013). Due to such climate changes, the ecosystem has been interrupted in which agriculture and food security has been greatly affected. Many parts of Africa have been more vulnerable to Climate changes specifically in agriculture, food, and water. Whereby sub-Saharan Africa is expected to suffer the most in agricultural production and water insecurity, coastal flooding, extreme climate events, and increased human health risks (FAO, 2007).

Our knowledge of the causes of changes in climate and change is limited in part because there are many possible causes and they include; changes external to the climate system as well as internal drivers which force climate to behave in specific ways (Thomas, et al., 2003). Climate change is characterized by weather variations that result in warmer temperatures, changes in rainfall patterns and increased frequency and perhaps the severity of extreme weather (Wheeler *et al*., 2013).

Exposure, nature, and the degree in which the system is exposed to climate change extremes, the world population experiences differences in climate changes where

some parts are greatly affected and some less affected. It very well recognized by a normal rate of individuals (family units) in groups who are exposed to or specifically influenced by primary climate hazards (for example storms, floods, droughts) to add up to the population in a zone. Each group of people (or family units) in the exposure part is specifically influenced by a climate hazard (Oppenheimer, 2017).

Sensitivity to climate change extremes is how much the population is influenced or affected, either unfavorably or advantageously, by climate-related events. Sensitivity is characterized as how many explicit groups of individuals (for example females, youths and old people, farmers, pastoralists) in specific region or area are helpless to climate hazard occasions. Population sensitivity can be distinguished by an average rate of individuals (family units) to the total population in a region. Each specific group of people (or households) is therefore, a socially vulnerable index factor, and so sensitivity has sub-components, which include demographic and socioeconomic groups (Oppenheimer, 2017).

Adaptive capacity to climate change includes the assets and abilities that a network can convey to the undertaking of diminishing risk and vulnerability`. It can be identified at the local sub-population level by total estimation of the capabilities of households to adapt to natural hazards, relative to the capabilities of the broader population in a specific area. Thus, each group of people (or households) represents specific capacity, made up of a diversity of elements. The five sub-components of adaptive capacity are natural, physical, human, social and financial capitals (Oppenheimer, 2017).

### 2.2.3 Food Security

Food security is the state of having reliable access to a sufficient quantity of affordable, nutritious food. A changing climate, growing global population, rising food prices, and environmental stress will have significant but unpredictable impacts on food security over the coming decades. There is an urgent need for adaptation plans and policy responses to global change, including options for water management, land use patterns, food distribution, post-harvest food processing, food prices and health (IFPRI, 2019).

### 2.2.4 Determinants of Food Security

"Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food d preferences for an active and healthy life" (FAO, 2006). Food security is determined through availability, access, utilization and stability.

#### 2.2.4.1 Food Availability

Food availability addresses the "supply side" of food security and is determined by the level of food production, stock levels and net trade (FAO, 1996; FAO, 2006).

#### 2.2.4.2 Food Access

Adequate food supply at national or international level in itself does not guarantee food security at the household level. Concerns regarding inadequate access to food have led to a greater focus on production, spending, markets and prices in achieving food security goals (FAO, 1996; FAO, 2006).

#### 2.2.4.3 Food Utilization

This is commonly understood as making the most of different nutrients in the food by the body. Individual intake of enough energy and nutrients is the result of good care and feeding practices, food preparation, and diet diversity and food distribution within the home. This establishes the nutritional status of individuals combined with good biological use of food consumed. (FAO, 1996; FAO, 2006).

#### 2.2.4.4 Food Stability

This denotes the consistency of use, quality and access over time of the other three dimensions. It ensures that if you have insufficient access to food on a regular basis, you are still deemed to be food insecure, which causes worsening nutritional status. Unfavorable weather, political instability, or economic factors (unemployment, rising food prices) may affect one's food security status (FAO, 1996; FAO, 2006).

## 2.3 Theoretical Review on Climate Change and Food Security

### 2.3.1 The Cultural Theory of Risk for Climate Change

The cultural theory of risk states “how risks are framed corresponds to different types of worldviews”. This is a theory which was originally developed by an anthropologist Mary Douglas and her colleagues. Over the past 20 years, it has developed into an essential paradigm for understanding how groups in society perceive hazard and build confidence or mistrust in institutions that establish and regulate risk. In respect to the threat of climate change, this means that people's perceptions of climate change are influenced by their social interactions and cultural worldviews that include fundamental beliefs about society and nature.

Assumptions of the theory: There are four competing worldviews that act as culturally informed classification systems that allow individuals to choose knowledge of certain risks to adhere to a specific way of life.The study of Douglas was told by an earlier British classifying anthropologist. According to this work, Individuals and societies have been known to have complete relationships and expectations, but the evolution of cultural risk theory has shown that people change their risk priorities over time depending on different conditions and experiences.

Market individualist: Entrepreneurial, or organization of the market in which individualism and competitiveness are essential to market success. We prefer to see climate as being biologically variable and this natural process cannot be adjusted by humans.

Hierarchical bureaucracy: Distinguished roles, characterized by rules and routine procedures to maintain the system, are seen to contribute to the functioning of the entire system. The hierarchical bureaucratic worldview is high-level and high-level, with strong social relations mainly vertical and regulated by various rules Nature and climate are therefore controllable and responsive of some human influence and will therefore tolerate human action to some degree, and scientific experts may recognize these tipping points.

The fatalist: The fatalist worldview is low group and high grid with weak social bonds and resigned to a stratified society governed by rules. Fatalists tend to be the most vulnerable and marginalized in society. As such, they are usually not interested in systems of governance or resource management (i.e., the three rather than four forms of institutional culture). Nature and climate are changeable and essentially

random and unpredictable to them.

Egalitarian group: Emphasis is on cooperation rather than competition. Decisions are made by consensus. Social solidarity and equality are highly valued. Egalitarian group worldview is a high community and low grid with strong social ties between people who subscribe to a few strict rules and a collectivist's general philosophy. Nature's underlying misconception is that nature is fragile and with culture in hazardous balance. They tend to view the human-nature relationship as lying in a delicate equilibrium, vulnerable to human influence leading to collapse.

How groups of people conceptualize the operation of nature has an effect on the viability and acceptability of climate change and planning. The cultural theory of risk for climate change approach, facilitates understanding and the application of cultural theory to global environmental risk issues, such as climate change. McNeely (2014) conducted a case study to show how the explanatory insight provided in this theory's applications clarifies how people experience and respond to climate change issues.

The study found that it has real-world implications because we will understand what behaviors are important to take and will be socially acceptable in order to reduce risks by understanding how people view risks. They argued that this approach would help diagnose obstacles to adaptation to climate change, support better communication through framing / reframing environment based on shared understanding and collective learning, and help move from conflict to collaboration through better negotiation of diverse world views.

Crate (2011) on the study of climate and culture intended to understand community level climate adaptation used the Cultural Theory of Risk for Climate Change. The field research that was conducted using ethnographic methods like In-depth Interviews, participant observation and discourse analysis in four places that is; Alaska, Tuvalu, Colorado and Oklahoma. Such areas were negatively impacted by the consequences of climate change.

Using Douglas analysis on different society's perceptions of environmental pollution and impurity, the study worked with local small-scale communities in marginal environments that were adversely affected by climate change. The study was able to obtain enough information based on different perceptions which related to their experience of the nature of places they lived. The study also reveals that people from the same areas had different perceptions and understanding about the same incident of climate change impacts in their areas for example cases in Tuvalu and South Colorado.

To evaluate the impact of climate change on food safety in Monduli, the study used cultural theory of risk to explore community perceptions about climate change. Specifically, the study examined community members' awareness of the impact of climate change (temperature and rainfall) on food security in their households. Since the study was conducted at local community of Monduli, the researcher obtained such information from people around the area with different experiences, using qualitative and quantitative methods such as In-depth interviews, observations and questionnaire. Similarly, Douglas studied the views of environmental pollution and impurity in different societies (Douglas, 1966)

## 2.4 Empirical Literature Review

### 2.4.1 Rainfall and Temperature Trends

While our understanding of how extreme weather conditions are getting affected by climate change is still developing, evidence suggests that extreme weather conditions may be affected even more than anticipated (Cutting*et, et al.,* 2011). Extreme weather means, The incidence of climate change has increased the demand for food, with negative impacts on crop production, fisheries and animal health and productivity, particularly in sub-Saharan Africa and south Asia, where there are more people living in poverty. (Puttanayak *et al*., 2014)

Average global surface temperatures have been reported since the late 19th century with a rise of about 0.6 ° C ± 0.2 (95% confidence interval). A rise in temperature was observed in two phases in the 20th century, from 1910 to 1945 and to the present (Jones, 2001). The 1976 warming trend (0.17 ° C / decade) was slightly higher than the 1910-1945 era. Nonetheless, the projected future temperature increase is predicted to range from 1.4 ° C to 5.8 ° C over 21st century. If the existing GHG emission rate persists (Salma, *et al*., 2017). On the other hand, climate change is already being reported as the warmest in the past 1000 years with the last 60 years (Wassmann, *et al.,* 2007). The latest warming period on land is faster than the warming of the ocean (Salma, *et al.*, 2017).

Both maximum and minimum temperatures in Tanzania indicate statistically significant rises in patterns at monthly and annual time scales. The mean annual temperature anomaly decreased by 0.69 C, whereas the number of hot days increased by 9.37% (Chang'a *et al*. 2017). The seasonal rainfall patterns in the bi-model zones

have been variable depending on the zone and the season in question. A mixed decreasing and increasing trend in seasonal rainfall is observed in March, April and May as well as October, November and December seasons (Munish, 2009).

### 2.4.2 Climate Change and Trends of Food Security

Climate change has affected rural incomes and livelihoods. There is an expected increase in climate disasters whereby poor people who are mostly small-scale farmers and farm workers are more vulnerable to the consequences of disasters like this. Increasing drought and floods are sharply changing and reducing the incomes and population that also lead to asset losses hence disrupting the sustainable livelihood of the population. As the food supply is declining due to climate change, food prices are expected to rise further where most of the share of income will be spent on food. The majority who are low-income earners in these countries is the one most affected since most of them are net buyers of food (FAO, 2016).

Food access measures the capacity to secure powers, defined as a collection of resources (including legal, political, economic and social) needed by a person to obtain access to food (FAO, 2003). Historically, food security was primarily related to domestic food production and global trade. (Maxwell, 2001). Access to household food is the ability to obtain enough quality and quantity of food to fulfill the nutritional requirements of all household members. Physical and financial capital, as well as social and political factors and being able to decide access to food. Food access is also globally impacted by climate variability (IPCC, 2007).

The world's knowledge and definitions of access to food have now expanded to include households and individual food access. Food is distributed by market

mechanisms and non-market mechanisms. In terms of affordability, aspects that restrict people's access to enough food through markets are considered. Aspects holding income-generating capacity; sums obtained for sold commodities, amount daily food basket to the average daily income (FAO, 2006). Food productions that are not related to markets are tied to individual eating, food production activities in the family, community or giving food allocation schemes. Rural based people always are subsistence farmers, climate change impacts on food production might reduce food access and limit their food choice in their localities (IPCC, 2007).

The amount of food supply in the family may decline the level required which will reduce the quality and quantity of food intake, and for those who are no farmers in urban and rural areas with low income, will be affected more on food choice (IPCC, 2007) Global rapid increase of urbanization is growing every year and high proportion of the urban population that is rising is poor (Ruel *et al.*, 1998). Poverty rates are rising in many cities and more urban residents are facing difficulties in accessing the food they need. The urban poor spend 60 percent or more of their income on food in some developing countries (FAO, 2005).

Such a key factor is a measure of persistent poverty which can also be used to assess when people have fallen into temporary food insecurity, leading to lower food supply and higher prices and a rapid decline in household income and food security. Ongoing population growth in urban brings food and nutrition challenges that are worsened by changes in food demand and markets, rising food prices and climate change impacts (FAO, 2006).

Farming households rely on what they get every year from the sale of some or all their crops and animals. Subsistence farmers are not treated like large-scale farmers in developing countries. And if their crop yields are not competitive or fail to grow, they have nothing while at the same time food price rises (FAO & UN, 2008).In several household's food is obtained through buying or trading, climate change impacts on income earning activities affects the ability of the families to buy food of which the more the extremes of climate change, the difficulties in access of food because of scarcity and price increase (IPCC, 2007).

The increase in seasonal demand in agricultural labor caused by changes in production practices are due to climate change and can have an absolute or harmful effect on income-generating capacity that also has an in impact on food access (FAO, 2007).Crop failure also reduce the level of food access at an individual and household level, this is due to factors such as drought, floods, frost or pests that may be caused by climate (IPCC, 2007). Availability and supply due to changes in crop production are the most direct impact that climate change is projected to have on food security. Sub-Saharan Africa is marked by dependence on local food supplies by a large segment of the population. For their food needs, many communities rely largely or exclusively on their own subsistence farming, with marginal groups especially dependent on climate-sensitive resources (Heather *et al.*, 2010).

For example, higher temperatures are expected to have a negative overall effect on crop productivity by reducing crop growth and length. It is generally expected that the impact of climate change on food availability in sub-Saharan Africa will be significant. This is primarily because of the weakness of subsistence farmers, who

are thought to have low capacity to cope with environmental stressors (Heather *et al*, 2010).

Progress towards global nutrition targets has been poor and most countries need to increase efforts, especially regarding reducing anemia in women of reproductive age as well as stunting and wasting in children (FAO, 2017).Food price is one of the indicators of climate change on agriculture, availability and consumption shows that there will be an increase in the prices of maize (Corn), rice and wheat by 4, 7 and 15% respectively higher than in historical times by 2050 in Sub Saharan Africa, whereas sweet potatoes, yams, cassava, millet, and sorghum will increase by 26,20,5 and 4% respectively. As the result of this trend, income generated by poor households is often insufficient to afford the cost of a nutritious diet, particularly since not all household income is spent on food with the lowest expenditure of 70 to 80% on food (UNDP, 2012).

There is a growing threat to food security and nutrition in Africa as a result of climate change and is a particularly serious concern to countries that rely heavily on agriculture. In general, reduced precipitation and higher temperatures are already impacting negatively on the yields of staple food crops, although there is some spatial diversity. By 2050, climate change will cause another 71 million people worldwide to be food insecure, more than half of them in sub-Saharan Africa (FAO, 2018).

According to FAO (2006), most African countries are net importers of food, with imports of between 25% and 50% of food consumed in sub-Saharan Africa. For

example, Africa's cereal import bill was estimated at approximately US$ 22 billion in 2008 and approximately US$ 10 billion in sub-Saharan Africa in 2008, a rise of 30% and 35% respectively over 2007 rates (Kamara, 2009). Over the past 10 years, countries in sub-Saharan Africa have had economic growth with an average of 4.5%. However, there has been slow growth in agriculture which is the major food source in these countries. Higher food prices hinder demand for food, since the ability to afford both agricultural commodities such as basic staples mostly cultivated in this area and livestock products have declined due to climate change. As a result, the supply of calories in sub-Saharan Africa decreases by 1.3% or 37 kilocalories per capita per day (IFPRI, 2010).

Due to the climate change factors, undernourishment has shot up from 20.8% to 22.7 % from 2015 to 2016, this added to the number total people undernourishment in the world 2016. A larger population percent in the region due to their inability to access food, severe food insecurity has increased in Sub-Saharan countries. Despite a rising prevalence of malnutrition, rates of stunting continue to decrease while levels of overweight and obesity increase, especially in Southern Africa. Climate changes in Tanzania will have increased from $1^0$C to $2^0$ C by 2050, this will affect key sectors such as agricultural production, health, water availability, coastal zones, energy use, infrastructure, and biodiversity as well as ecosystems (IPCC, 2007).

On his study about smallholder farmers' perception of climate change with meteorological data, Mkonda (2018) shows that the south, western and northern highlands there is a decrease in the amount of total annual rainfall from 1500 to 1200 mm per year and number of days. Trends of decline in total annual rainfall in other

zones ranged from 1000 mm to 900 mm per year. According to the study, in the past 30 years, there has been such variations of rains which have eventually caused fall in crop yields, this was also agreed by scholars (Kilembe, 2013).

The change in the climate has resulted to fall in agricultural production which includes change agro-diversity, crop pests, and diseases. Maize as one of the major foods and cash crop has decreased in production because of climate changes where as some of the notable crop pests include maize streak, cassava fusarium, banana Panama, batobato cassava root rot and rust in green grams (URT, 2012). With such variations of climate change, the level of agriculture is still declining and at the same time, the ability of response to it is limited. There has been the implementation of copying strategies however they are overwhelmed by such climate change impacts. This means that climate change already has an economic and social impact on Tanzania. Human health has been greatly affected and the nutrition intake is inadequate as well which is more sensitive pregnant mothers, children, youth and elderly, also affected the life expectancy (URT, 2012).

The climate change incident is very high for about 75-80% of Tanzanians because they earn their living through smallholder farming, making it necessary to incorporate climate change adaptation measures into agricultural development strategies (URT, 2011). Climate changes have shifted and shortened the beginning of the growing seasons. As a result, crop productivity has been decreasing due to delays in planting. In addition, prolonged droughts have been affecting the growth of crop yields.

According to the 2012 Comprehensive Analysis of Food Security and Vulnerability (CFSVA), the overall food security situation in Tanzania continues to improve over the years. Nevertheless, CFSVA found that rural households are more vulnerable to food insecurity than urban households; households in drought-prone bimodal rainfall (north and west) reported food shortages more frequently; that the more agricultural households rely on their own goods, the more susceptible they are to food insecurity (FAO; 2013). A 2013 study entitled Trends in Agricultural Dynamics and Food Security in Tanzania shows that although the food of the nation (Kahimba, 2015).

Agriculture is a major source of food in Tanzania, but due to various constraints, this sector has not realized its full potential to establish food security in Tanzania. The change in the climate has resulted to fall in agricultural production which includes agro-diversity changes, crop pests and diseases. Maize as one of the major foods and cash crop has decreased in production as a result of climate variations whereas some of the notable crop pests include maize streak, cassava fusarium, banana Panama, batobato cassava root rot and rust in green grams (URT, 2012).

Due to climate change, the level of agriculture is still declining and at the same time, the ability of response to it is limited. There has been the implementation of copying strategies however they are overwhelmed by such climate change impacts. This means that climate change already has an economic and social effect on Tanzania. Human health has been greatly affected and the nutrition intake is inadequate as well which is more sensitive pregnant mothers, children, youth and elderly, also affected the life expectancy (URT, 2012). Since agricultural sector is top to the economic prosperity with 25% contribution to the GDP and 24% of its exports, climate change

is expected to disrupt its contribution to the national economy. Climate change incident is very high for about 75-80% of Tanzanians since they earn their living through smallholder farming, making it important to integrate climate change adaptation measures into agricultural development strategies (URT, 2011).

During excess rainfall especially in the coast, plateau, and alluvial plains, there has been suppression of crop development due to floods. This has been somewhat okay for some water demanding crops like paddy. Since the temperature has also increased, it has affected the production of varieties of crops whereas maize production has been greatly affected (Mkonda, 2018).

### 2.4.3 Climate Change and Growing Seasons

In recent past, changing climate and weather extremes have jeopardized progress in reducing poverty and food insecurity, while also having a detrimental effect on ongoing development efforts. Economic parts that are generally dependent on climate conditions, whether legitimately or by implication are most eminently dependent on farming and fisheries (IPCC, 2012). However, as a result of increased ecological and demographic stresses, the loss of natural resources continues to exacerbate the intensity of the consequences of climate change. Overall, there is serious concern about the rising threats to households and individuals ' current income and consumption patterns from these sectors (Foresight, 2011; IPCC, 2012).

Global model evidence suggests that farming populations residing in tropical regions are expected to experience declines in their agricultural yields and incomes. As a result, poverty, food insecurity will increase incidence and intensity. Estimates for

these regions suggest that yield losses between 5 and 20 percent for maize, wheat and rice should increase local temperatures by 3 ° C; yield levels may be halved if temperatures rise by as much as 5 ° C. Expected economic damage range from just 0.5 to 23.5 percent of the gross domestic product (GDP) of a country. In temperate regions, yields can actually rise or slightly decrease, resulting in changes in GDP ranging from small losses to gains of up to 13% (IPCC, 2007; Tol, 2009).

The factors associated with climate change in Tanzania contribute significantly to food shortages and poverty, with much of the food shortage in years of drought and flooding. Drought, crop pests and diseases, low soil fertility, animal diseases and low household incomes were the major causes of food shortages (URT, 2012). In 2009, severe drought was experienced in the northern part of Tanzania, where most rural dwellers are pastoralists, especially Manyara and Arusha. Households could not rely on earnings from the sale of their livestock because buyers demanded very low prices. They became more dependent on food aid and at that very low price sometimes had to sell their animals in order to have money for family use and send their children to school. The drought subjected the country to hunger and food insecurity as most of the animals died due to lack of pastures and water. Children were taken out of school to work to raise household income and boost food security, impacting school attendance (URT, 2012).

The country's climate change effects are widespread and significantly interfere with agriculture, while reducing society's ability to deliver services at the same time. However, the impacts of climate change on people are overwhelmed by the coping mechanisms. Some positive steps have been taken by various institutions including

the government in the fight against climate change; however, the efforts made so far are insufficient. Additionally, Tanzania's response to climate change is hampered by inadequate resources and poor coordination and implementation of combat measures. Generally, the current climate variability in the nation is a concern for the future and needs to be addressed (Shemsanga *et al.,* 2010).

The climate change already has an economic and social impact on Tanzania. The research by Semsanga *et al,* (2010); shows that rural residents in Tanzania are more vulnerable to the effects of climate change than urban residents, partially due to their limited resources, inadequate exposure to different technology and over-reliance on natural resources threatened by climate change. Survival skills and local responses to climate effects have done little to help the country's poor, they are unlikely to be useful if the impacts continue and become severe.

**2.5 Research Gap**

Tanzania literally being identified among the sub-Saharan countries that are vulnerable to the climate extremes, the reality has been identified from various researchers who have empirically described the general impact of climate change on agriculture, human health with an emphasize more in the northern part of Tanzania where there is a great challenge of climate change impact (URT, 2012; Kilembe, et al., 2013).

Since northern Tanzania is one of the arid-semiarid climatic zones affected areas by climate change, apparently is that more researchers have studied about this area however most researches have focused on livestock keeping communities and

rangeland, such as the (URT, 2012; Mwakaje, 2013), and (Maleko *et al*.,2015). More interrelated impacts such as death off livestock, during water sources, declining ability to purchase food, family instability, and migration and related others are some of the impacts discussed. From empirical studies such as Shemsanga *et al.*(2010); URT, (2012); Kimaro, (2018); Theodory *et al.*,(2014), shows that research on coping mechanism to enable livelihood support, climate change and related animal diseases, and livestock production has been done to pastoralists.

But there is a need for a broad understanding temperature and rainfall trends and impacts on the relationship among affected aspects of community livelihood and not in separate in this area since not only the pastoralists live in and contribute to its economy. This called for a study on impact of climate change on food security in northern zone that covered Monduli area that was inclusive of pastoral areas and mixed practice, that is famers, pastoralists, and others involved in other informal and formal sector.

### 2.6 Conceptual Framework of Food Security and Climate Change

According to FAO & NRCB, 2008; Food systems exist in the biosphere, along with all other manifestations of human activity. Some of the significant changes in the biosphere that are expected to result from global warming will occur in the more distant future, because of changes in average weather conditions (Figure 2.1). The most likely scenarios of climate change indicate that increases in weather variability and the incidence of extreme weather events will be particularly significant now and in the immediate future.

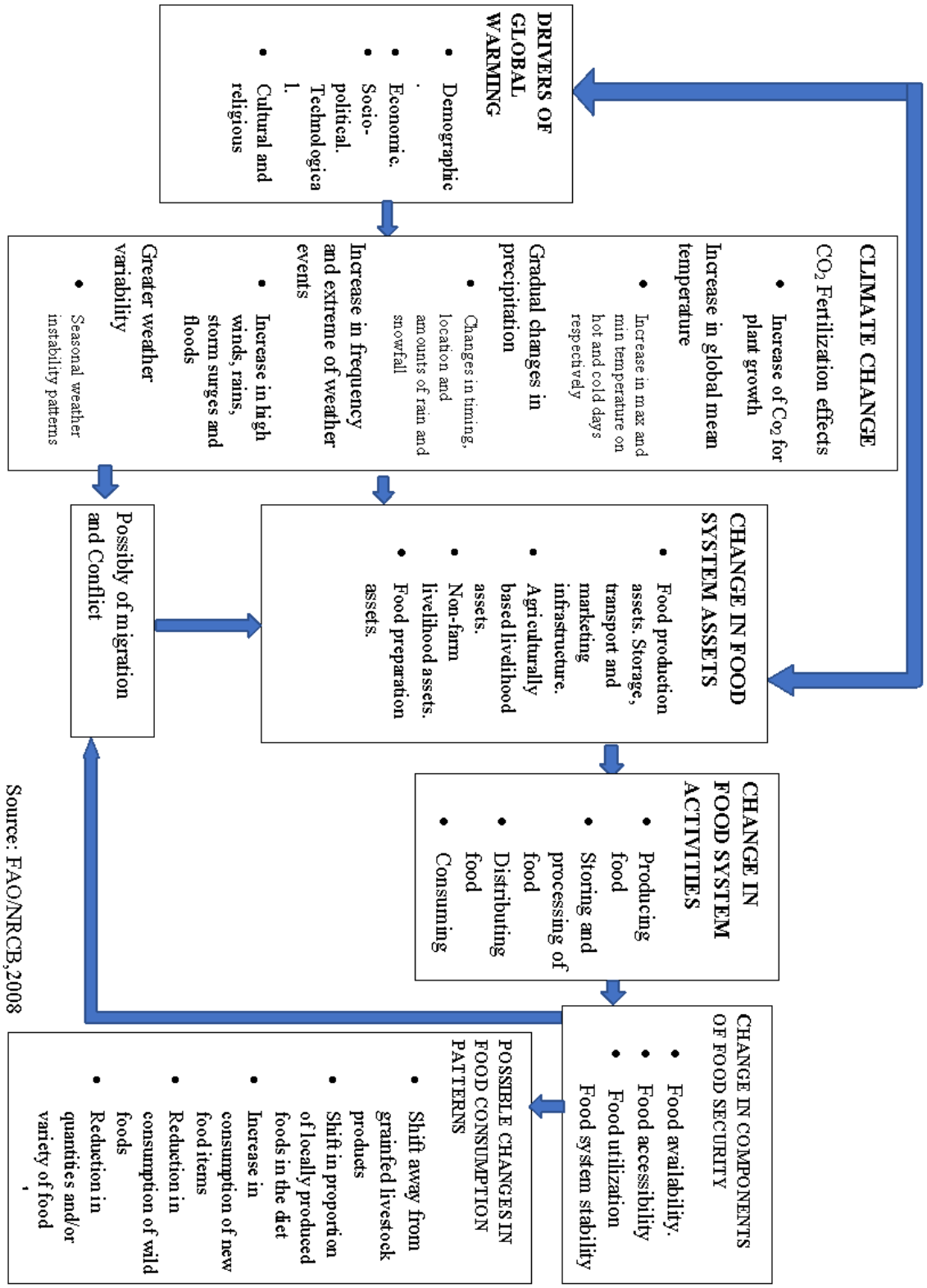


**Figure 2.1: Conceptual Framework on Climate change and Food Security**

The predicted rise in mean temperatures and precipitation will not result in continuous gradual changes but will instead be observed as hot spell and precipitation events increase in frequency, duration and intensity. While the annual occurrence of hot days and maximum temperatures are expected to rise in all parts of the world, the average global increase in precipitation is not expected to be distributed evenly around the world. In general, rainy regions are projected to become wetter, dry regions are projected to dry. For this study, a conceptual framework was built to highlight the variables defining the food and climate systems as referred to Figure 2.1 on drivers of global warming.

Figure 2.1 also shows the framework for climate change and food security (CCFS) how climate change affects the outcomes of food security for the four components of food security; availability, accessibility, use and stability of the food system in various direct and indirect ways. Variables of climate change affect biophysical factors such as plant and animal development, water cycles, biodiversity and nutrient cycling, and how they are handled by farming practices and land use for food production. Climate variables, however, also influence physical / human capital – such as roads, storage and marketing infrastructure, buildings, productive assets, electricity grids, and human health – that indirectly alters economic and socio-political factors that regulate food access and use and that threaten food system stability.

All these impacts are manifested in the way the activities of the food system are performed. The concept highlights the need for incremental changes to the operations of the food system throughout the food chain to cope with climate change

impacts. The variables of climate change considered in the CCFS framework: Conceptually in Figure 2.1 the CO2 fertilization impact of increased concentrations of greenhouse gasses in the atmosphere; increased mean, maximum and minimum temperatures; incremental changes in precipitation: increased frequency, duration and intensity of dry spells and droughts; shifts in timing, duration, intensity and geographical location of rainfall and snowfall; rise in storm frequency and intensity, greater variability in seasonal weather and changes in the beginning / end of growing seasons.

Evidence from Figure 2.1 indicates that more frequent and intense extreme weather events (droughts, heat and cold waves, severe storms, floods), rising sea levels and growing anomalies in seasonal rainfall patterns (including flooding) already have an immediate impact not only on food production, but also on food distribution systems, food emergency incidence, livelihood properties and human health in rural as well as urban areas.

In addition, the conceptual framework in the Figure 2.1 shows less immediate impacts from gradual changes in mean temperatures and rainfall are expected to result. These will impact land suitability for various crop and pasture types; forest health and productivity; marine resource distribution, productivity and community composition; occurrence and vectors of various types of pests and diseases; the biodiversity and ecosystem functioning of natural habitats; and the availability of good quality water to produce crops, livestock and inland fish. Arable land is likely to be lost due to increased aridity (and related salinity), depletion of groundwater and rise in sea level. Food systems will be impacted by climate change-induced domestic

and external migration, resource-based conflicts, and civil unrest.

### 2.6.1 Relevancy of the Conceptual Framework to the Study

From the knowledge obtained from the conceptual framework as shown in Figure 2.1 above, the study will review two major climate factors which are temperature and rainfall by determining their mean annual, minimum and maximum temperature so that to examine nature of their trend and impact on food system assets such as food production. Also the study will examine the levels of food production, main dietary food to identify if a change in climate factors leads to changes in trend of quantity in food production, access and availability through respondents perceptions lined with their experience in the study area.

Also the study will determine the levels of trend in food production examining perception on food access, availability and use which is important to update the conceptual framework on food security components for the case of Monduli district.

# CHAPTER THREE

# RESEARCH METHODOLOGY

## 3.1 Introduction

This chapter highlights the research methodology used to carry out the study. It covers research design, target population, sampling design, methods of data collection, analysis and techniques of data, validity and reliability, and ethical consideration.

## 3.2 The Study Area

This study was carried out in the district of Monduli. It is one of the 7 districts that make up Arusha region in northern Tanzania. Monduli district is located at 3 ° 20′S latitude and 36 ° 15′E longitude. It is bordered to the north by Kenya, to the east by the Kilimanjaro region and Arumeru district, to the south by Manyara region and to the west by Ngorongoro district and Karatu district. Monduli District had a population of 158,928 people at the latest census (2012), with an average of 4.7 people per household (NBS, 2012). It is projected that the district population is growing at a rate of 4.3% per household (URT, 2016). The Maasai people (97%) are the major ethnic group living in Monduli district. For their livelihoods, the Maasai primarily depend on livestock, with some subsistence farming practices also being performed, mostly in agro-pastoral communities (Theodory and Malipula, 2014).

There are two major agro-ecological zones in the district. The highland region, which includes isolated mountains with an average altitude of 2000 m above the sea level, defined by sub-humid weather and an average annual rainfall of 500 mm to 900 mm (ADF, 2003). Crop production and livestock farming are the main economic

activities in the highland region. The lowland is made up of arid and semi-arid rangelands covering about 85% of the district of Monduli. These areas receive an average annual rainfall of between 200 and 600 mm, and the main economic activity is animal husbandry.


**Figure 3.1: Monduli District Map**
**Source**: ARC-GIS modified by researcher, 2019

The district has a bi-modal rainfall pattern with medium rainfall between November and December, moderate rainfall between November and December and long rainfall between March and May (ADF, 2003; Kaswamila, 2017). The researcher selected Monduli district for this study because of its continued climate change extremes such as droughts, lack of water that increase worry for food security in the area (Saringe, 2011; URT, 2017). The study area is exposed to climate change risk because its majority depends largely on livestock and farming for their livelihood, consisting mainly of arid / semi-arid lands that have undergone climate change, including rising periods of drought and unpredictable rainfall (Theodory, 2014; Kimaro, 2018).

Monduli district is also an area surrounded national parks such as Tanrangire, Ngorongoro and Lake Manyara where the policy for TANAPA on tourism and environmental conservation does not allow all human activities such as farming and grazing, hence limiting the ability of the community access to food.Hence the study found out it would update new information to policies that needs to be implemented in support for climate change understanding and adaptation in Monduli district.

### 3.3 Research Design

Research design is a constructive strategy for collecting a sample from a given population before any data is collected. (Kothari, 2004). The study used a cross-sectional research design. This design was used because it is done at one time and presents the basis for understanding the experiences of the households about food security in the context of climate change. Besides, the design also helped in understanding aspects of the study such as the awareness of climate change in Monduli. It presented the researcher with freedom and flexibility in terms of research methods in case there was a need to change especially if some challenges related to data collection.

### 3.4 Study Population

The population to be used in this study was in Monduli district in Northern Tanzania. Monduli district has 33011 households with a population of 158,929 from which 75,615 are males and 83,314 are females. The district has the average household size of 4.7 with a sex ratio of 91. From such population size, 75913 are aged between 0-14, whereas 77897 with age between 15-64 and 5119 ages from 65 and above (NBS, 2012).The study took place in three villages of Makuyuni, Mswakini and Eslalei

found in three wards respectively among fifteen in the district because they consist of mostly arid/semi-arid lands that have experienced severe climate unpredictability including increasing drought periods and unpredictable rainfall (Kimaro, 2018). Also they are the villages that consists high population density as compared to others.

Since the unit of measurement for the study was the household the study selected households from the three villages whose total households are 6549 (NBS, 2012), the three villages are also confined within two major ecological zones characteristics which are highland and low land zones, this implies that the study population represents other areas of Monduli because it has average of ecological zones of the district, and lastly the three villages are also bordered by three national parks, Lake Manyara, Tarangire and Ngorongoro which have restrictions over land use in the district but also farming activities have been affected by hostile wildlife coming from these national parks that also contribute to food insecurity in the area.

### 3.5 Sample and Sampling Techniques

The level of precision (sampling error) criteria was used to determine the sample size, which is the range in which the true value of the population is estimated to be. This range is often expressed in percentage points, ±5 % (Cochran, 1963).

#### 3.5.1 Sample Size

Monduli district has 33011 households (NBS, 2012). The population has farmers, pastoralists, both agro-pastoral famers and those who are neither farmers nor pastoralists. The National Sample Census of agriculture shows that Monduli district has 3286 farming households, 4144 livestock keeping households and 21075 both

farming and livestock keeping households (URT, 2012).

The study composed of sampling frame of 3876 households' heads obtained from three villages which are Makuyuni, Mswakini and Esilalei. The unit of sampling used household heads. Household heads were opted for that case because mostly they make most of decision in their households and so they have enough information about their households experience in relation the problem under study. The study used Yamane (1973), the formula for calculating the sample size for the study. Yamane formula for sample size calculation holds that "For 95% of sure results of the study, then there should be margin error lying between ±0.05, that is e=0.05.

Hence sample size formula; given the sample frame (N=3876)

$$n = \frac{N}{1+Ne^2}$$

Where as

$n$ = Sample size

N= Population size for households in the area where sample was obtained

e= Margin error /or the level of precision

n=3786/ (1+3786*0.05$^2$)

Hence, household sample size n=362

### 3.5.2 Sampling Techniques

### 3.5.1 Simple Random Sampling

For a study of 362 household heads, a random sampling technique was used from three sampled villages, this was because of the known underlying study population size. Sampled household heads were randomly obtained from the hatthat contained

households' heads from three villages of Makuyuni, Mswakini and Esilalei that have farming households, pastoralists and agro-pastoral. Among the total sample of 362; 139 households belonged to Makuyuni village, 117 from Mswakini village and 106 belonged to Esilalei village.

#### 3.5.2.2 Purposive Sampling

The study also involved12 key informants who were purposively selected, these were senior elders, former village leaders and extension officers,and this relied on their experience on climate change while living in the area, administration and responsibilities at the ward and village level.

### 3.6 Sources of Data

The study used both primary and secondary data.

#### 3.6.1 Primary Data

Primary data was collected through household questionnaire interviews and key informant interviews finally with observation. The questionnaire interview was used with the household head and In-depth interviews were applied with senior elders, former village elders and extension officers with enough experience in the study area. Data from the households was on household food security situation that is; access, availability, and utilization, climate change situation in the area. The In-depth interviews with key informants asked questions related to trends of climate change in relation to food security in the district for 30 years since 1988 to 2018, whereas the researcher used observation checklist on environmental evidence of climate change food-related challenges such as water, vegetation, crops, and cattle.

### 3.6.2 Secondary Data

Secondary data are data that already exists, these are obtained from various sources such as databases and official and certified information. From this study, the data on the trends mean annual (Maximum and Minimum) temperature and rainfall for 30 years (1988-2018) in Monduli district were obtained from the Tanzania Meteorological Agency (TMA) at Arusha Airport. This is because it is the weather station that records Monduli district weather and other neighbor districts in the Arusha region.

## 3.7 Methods for Data Collection

For this study qualitative and quantitative data were collected, using the two methods in this research study were to allow an informed conversation with information generated by both quantitative and qualitative methods of collection. Evidence suggests that, instead of reducing research opportunities by using either qualitative or quantitative approaches alone, a mixed methodology approach allows researchers greater scope for researching study problems using both words and numbers to support study, policies and society (Almalki, 2016). Therefore, the study used the following tools to collect data.

### 3.7.1 Questionnaires

The study administered 362 questionnaires, questionnaire were conducted through face to face with household heads, with closed ended questions. As people who have lived in the study area with enough experience in the study; household heads were expected to bring on board their experiences as well as knowledge on climate change together with its effect on household food security in the study area. Information

collected was grouped into four (3) categories, these being: Basic characteristics of the respondents, information regarding climate change, household food production and food security (Almalki, 2016).

### 3.7.2 In-Depth Interviews

The study conducted In-depth interviews with 12 key informants who were 2 extension officers, 4 male and 4 female senior elders and 2 former village leaders which allowed the researcher to seek new perspectives, ask relevant questions, and assess climate change indicator phenomena and their effect on food security in the district of Monduli.The researcher used note taking strategy to record information from each key informants key informant, Key informants were considered to be knowledgeable with enough experience in the study are. The choice of in-depth interviews over other qualitative data collection techniques was because it was the convenient method to provide the researcher with enough views from different experienced people who had first-hand information or knowledge on the topic (Adler, 2011).

### 3.7.3 Observation

The researcher used observation checklist to examine environmental evidence of climate change on food related challenges. Areas for observation were water availability and sources and quality, access and use, also vegetation of the area, crops and cattle. These were observed in three villages against three measure that is; extreme, moderate or lower quality of the nature (Adler, 2011).

## 3.8 Data Processing and Analysis Plan

The analysis involved statistical analysis, but also social perspectives to uncover the

depth of the impacts that climate change on food security in Monduli. In view of this, both quantitative and qualitative techniques was used to analyze the data (Adler, 2011).

### 3.8.1 Quantitative Data Analysis

The study used SPSS version 21 (Statistical Package for Social Science) version 21 for data analysis. Quantitative data on mean annual temperature and rainfall as well as district food security from 1988 to 2018 was used in quantitative analysis. The climatic data were used to show the trends in rainfall and temperature (Tmin and Tmax) in the district during this period. It was entered in the regression analysis, which is the main statistical method of analysis. Data on household level of food production was used to check perceptions on trends in food production and, also was used in the analysis to determine the relationship between climate factors and food security (Adler, 2012). To show the trends, line graphs were produced from these data using Microsoft excel in order to impose trend analysis.

Correlation and regression analysis was used to specifically establish relationship between the independent variables and the dependent variable and well as to determine the effect of the climatic variables on food security (Wooldridge, 2012). Descriptive statistics was used to analyze quantitative data and presented in percentages. The use of descriptive statistics was appropriate because the descriptive analysis support conversion of data in the basic characteristics like central tendency, distribution and variability. The descriptive statistics, charts, were used to present the data for further understanding and analysis.

### 3.8.2 Qualitative Data Analysis

A Content qualitative analysis approach was employed to compliment and enrich the statistical data to be collected from the respondents in the study area. This involved a comprehensive reveal of responses both from the household heads and In-depth interviews on food security situation. From these responses, main themes were identified, classified and then assigned codes. This enabled to capture opinions and experiences into the main text. Qualitative data was collected to explore experiences and views from the sampled households mainly on three aspects of the study. These are; perceptions on climate change, their household food security situation, seasonal changes and crop production (Skovdal, 2015).

With respect to households' perception of their food security, food security was measured based on the perception of the respondents regarding their household crop production and ability to afford to buy food. Also, observational was supportive to qualitative data analysis.

## 3.9 Validity and Reliability

Ngulube (2005) argue that validity and reliability refer to the quality of procedures or instruments (tool) to be used in a research, thus must be accurate, correct, true, meaningfully and right, therefore the researcher had to put these issues in consideration for the purpose of producing a meaningful document.

### 3. 9.1 Validity

Validity refers to how well a test measures what it is purported to measure. Pre-test

and pilot study was done to check the accurate of the measure, whereby questions were prepared and tested to some respondents to see if questions fit the variables. In the whole process of data collection, the study used different data collection instruments to obtain valid credible and reliable data. To maximize accurate level information searched and obtained from concerned and responsible respondents.

### 3.9.2 Reliability

Reliability is the degree to which stable and consistent results are generated by an assessment method. Validity is the degree to which the researcher measures what he wants to measure and how real the findings are. According to (Bryman & Bell, 2011), reliability of measurement is established by examining the stability and consistency of data. Thus, this research used Alpha coefficient of Cronbach to estimate the internal consistency and reliability of a set of two or more indicators. A computed alpha coefficient varies between 1 (denoting perfect internal reliability) and 0 (denoting no internal reliability). The reliability test providing Cronbach's alpha that is less than 0.70 is considered to have poor reliability and variables are acceptable when corrected item total correlation coefficient is 0.3 or more. Therefore, Cronbach alpha test of reliability was calculated for each variable based on household 39 sample size.

### 3.9.3 Ethical Consideration

Considering that the study was conducted in a rural setting, clearance was obtained from the district and local authority, in this case the, the district director and village headmen. The study also conducted informed consent where all participants were given an assurance of confidentiality and anonymity. The respondents were carefully

informed about the purpose of the study, the intended use of the data they obtained, and the potential outcome of the study.

### 3.9.4 Expected Results of the Study

The study expected the factors identified such as increasing temperature and declining amount of rainfall contributes to food insecurity such as, food access, availability and utilization, lowering number of meals per day, limiting vegetation cover, water scarcity, and fluctuation in crop production due to seasonal changes in Monduli district.

# CHAPTER FOUR

# FINDINGS AND DISCUSSIONS

## 4.1 Introduction

This chapter presents the research data analysis, presentation and discussions in line with the study objectives. It begins with the demographics of the sample and then the data and results for objectives. The results arising from analysis, presentation, interpretation and discussion of the data collected from the study respondents. Data collected were analyzed using statistical descriptive and inferential methods in line with the study objectives (3).

## 4.2 Demographic Characteristics of Respondents

The sample was drawn from three villages and three hundred sixty two households (362) where targeted to take part in the study and therefore the study reached 100% of target sample.

### 4.2.1 Gender of Respondents

The study administered 362 questionnaires in the households with household heads, of those interviewed, 55% were male headed households and 45% were female headed. This means there were 55% male headed households and 45% female headed households. The number of male headed households in the study area was therefore much more than female headed household.

The implication of this finding is that the representation of male headed households is stronger. It is important to note that because household responsibilities are gender specific especially in the rural communities, women headed households may not be

as productive as men headed households. In the villages for instance, some food production activities rely on access to male labour, without which women headed households may face delays that may lead to losses in food production. On the other hand, Mandleni (2011), points out that gender has no significant effect on climate change awareness, but on adaptation to climate change.

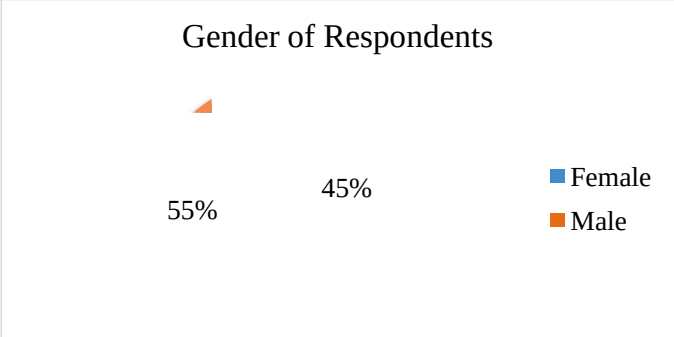


**Figure 4.1: Gender of Respondents**
Source: Research data, 2019

4.2.2 Age of Respondents

From the household survey, 25.41% of respondents were aged between 48-57 followed by 23.76% that were aged between 38-47 where as 17.96% aged between 58-67, 13.81% were aged between 28-37 and 11.05% aged between 18-27 where as 6.91% were aged in the age group of 68-77 , and only 1.10% was aged above 78.

**Table 4.1: Age of Respondents**

| Age group | Frequency | Percent |
|---|---|---|
| 18-27 | 40 | 11.05 |
| 28-37 | 50 | 13.81 |
| 38-47 | 86 | 23.76 |
| 48-57 | 92 | 25.41 |
| 58-67 | 65 | 17.96 |
| 68-77 | 25 | 6.91 |
| 78 and above | 4 | 1.10 |
| Total | 362 | 100 |

Source: Research data, 2019

From the table above, it implies that majority that is over 50% of the household heads are aged between 38 and 67, that means that with inclusion of the population between 15-64 according to ILO as a working age group, it means that the community has enough labor force which is more than 50%, this is the population that is supposed to work and to earn living for families.

### 4.2.3 Marital Status of Respondents

The study examined the level of marriage status at by the household heads. Data collected from Monduli shows that 76% of household heads are married where as 12% are unmarried and 12% are widows.

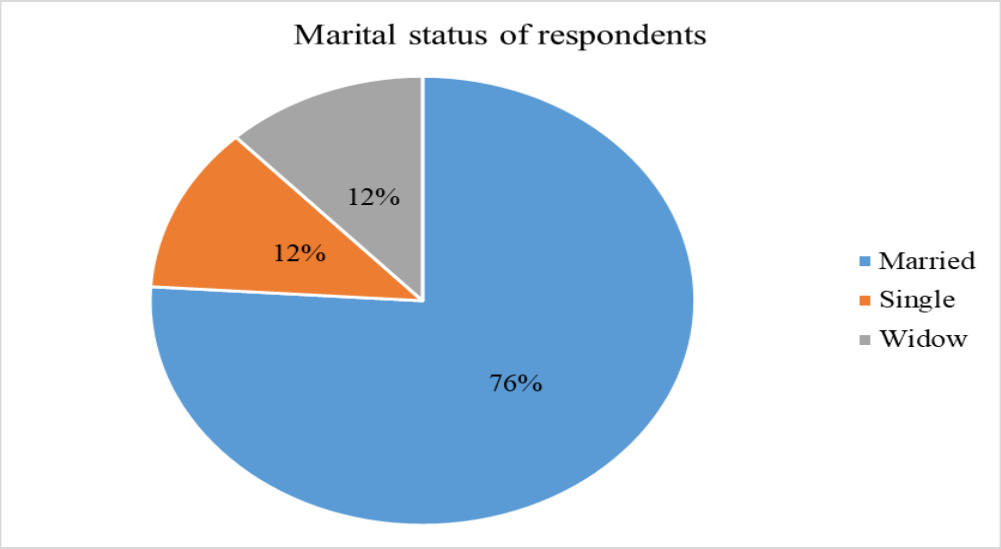


**Figure 4.2: Marital Status of Respondents**
**Source:** Research data, 2019

From the chart above it implies that 76% of household heads are married, this means they have responsibilities to make sure that their families are supplied with basic needs. The 12% is a population from the community that is still unmarried and other 12 is composed of widows, however due to gender roles in Maasai community such age group is also having specific responsibility in the community depending whether

they are males of female.

### 4.2.4 Education Level of Respondents

The s study shows that 53% of the population has not attended school at all and 41% have attended primary education where as 4% have attended secondary education and only 3% have tertiary education in the community.

**Table 4.2: Education Status of Respondents**

| Education level | Frequency | Percent |
|---|---|---|
| No School | 191 | 53 |
| Primary education | 147 | 41 |
| Secondary education | 14 | 4 |
| Tertiary education | 10 | 3 |
| Total | 362 | 100 |

**Source:** Research data, 2019

As there shows to be more than 50% of the population with n education it means that the rate if illiteracy is still high in the study area. Although there is 41% of population with education level of primary education still the community is overweighed by higher number of illiteracy that can be one of the obstacles towards development of the community.

### 4.2.5 Main Occupation of Respondents

This study demonstrates that household heads were found to engage in three major activities; farming, livestock keeping (pastoral) and doing both (agro pastoral). Hence responses were given based on the experience of respondents in their respective occupation.

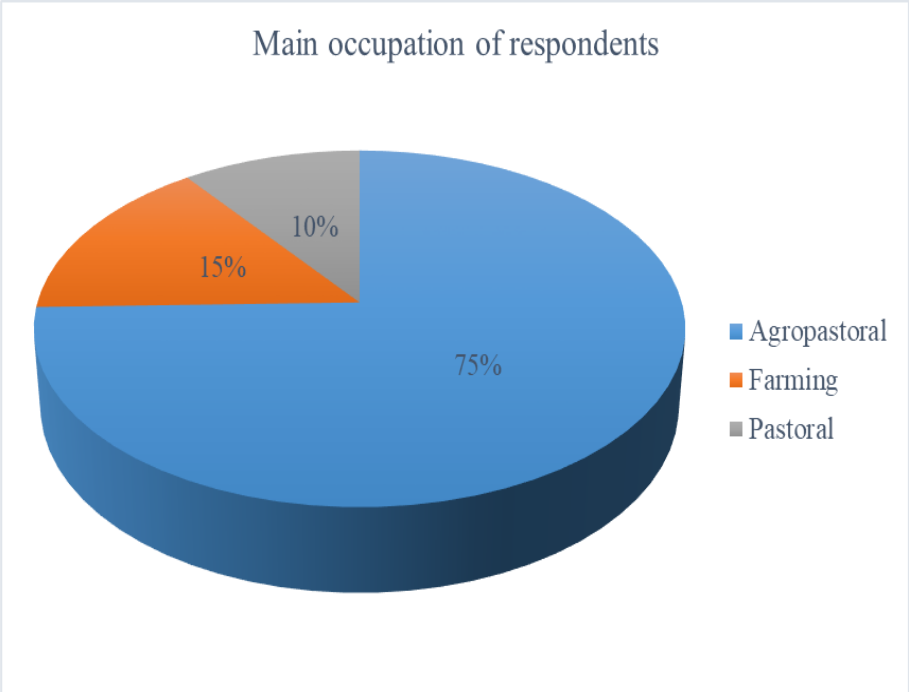


**Figure 4.3: Main Occupation of Respondents**

**Source:** Research data, 2019

This figure demonstrates that 75% of the household heads interviewed were engaged in agro pastoral activity where as 15% are only farmers and 10% are pastoralists. This confirms that livestock keeping, and agriculture are primary task for survival of the individuals in Monduli district and this tally with (Theodory & Malipula, 2014; Kimaro, 2018) who wrote about Monduli community being mostly occupied with agro-pastoral, farming and livestock keeping as a source of income.

### 4.2.6 Main Household Dietary Food

The households were asked to describe their main dietary foods. The responses from the household's shows that 37% of the people eat Ugali followed by 27% that eat meat and15% eat milk. Also minority of the people eat, rice, sweet potatoes and beans with percentage of 8, 7 and 6respectively.

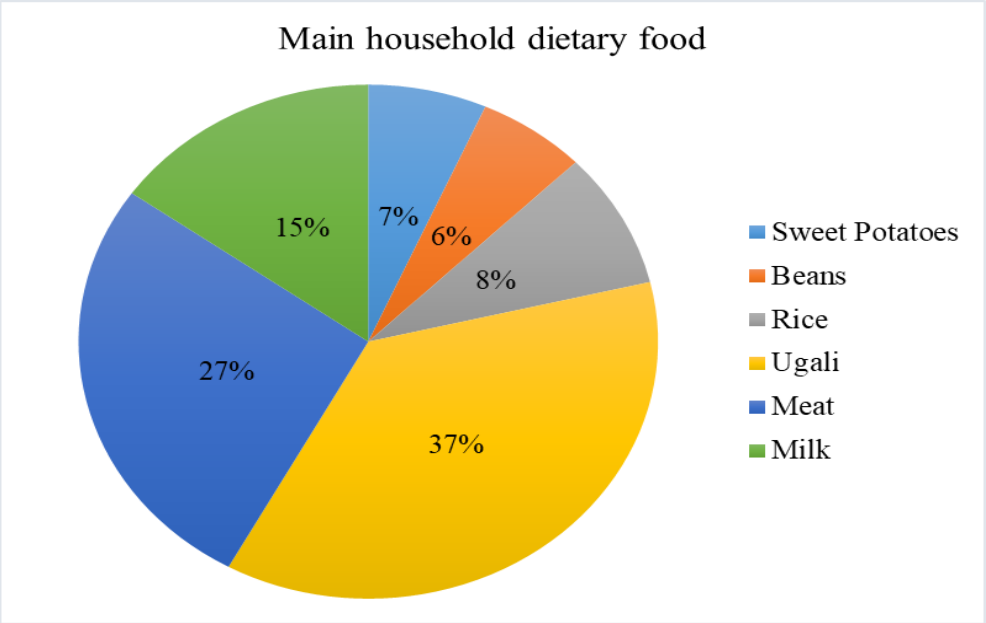


**Figure 4.4: Main Household Dietary Food**
**Source**: Research data, 2019

From the chart, it implies that Ugali is a major dietary food followed by meat in Monduli community, other dietary food is,milk, sweet potatoes. Food consumption in this community is accompanied by milk, rice, meat and beans. This means that if the meal served is either Ugali, rice or sweet potatoes, will be accompanied by either milk, meat or beans. Food is taken in categories of combination and thus from the study shows that 21% take such food in combination of sweet potatoes, beans and rice where as 79% take food in combination of ugali, meat and milk.

### 4.2.7 Households Income

In order to know the economic status of the household, participants were asked about the scale of their income. The study shows that 42.3% of respondent's monthly income ranging from 50,000 to 99,000and 34.8% which are very low-income groups where as 23% of the remaining population monthly income above 100000 Tanzanian shillings, all these income levels are relatively low to sustain household needs

including purchase of food as compared to GDP per capita (2018). This implies that households do not have a sustainable income to support their food security.

**Table 4.3: Household Income**

| Income levels (Tanzanian shillings) | Frequency | Percent |
|---|---|---|
| 0-49000 | 126 | 34.8 |
| 50000-99000 | 153 | 42.3 |
| 100000-149000 | 65 | 18.0 |
| 150000-199000 | 10 | 2.8 |
| 200000-299000 | 8 | 2,2 |
| Total | 362 | 100.0 |

**Source:** Research data (2019)

Due to such situation of lower income levels in the community of Monduli , it implies that they are not having quality standard of life and sustainable life as opposed to Ellis(2003) that livelihood must have cash and social profits, property rights, so that living standards can be preserved and sustained. But since in Monduli it shows that most households have no enough income to support and sustain their livelihoods, they are more vulnerable to extremes of climate change such as droughts and floods.

### 4.3 Climatic trends in Monduli District

Climatic trends in Monduli District were based on climatic variables including mean annual rainfall and temperature. Temperature factors measured were maximum and minimum mean annuals for the year. The study obtained climatic panel data from 1988 to 2018.

### 4.3.1 Rainfall Trends in Monduli District from 1988 – 2018

In order to determine the trends in rainfall over this period, mean annual rainfall data for the period was graphed as shown in figure 4.5 below. The means for the rainfall represents the average rainfall received in the district for each of the years from 1988 to 2018, despite changes in rainfall pattern being changing still changes are not significant as *P*.532. This data was obtained from Tanzania Meteorological Agency (TMA) Arusha Airport that also records climate data for Monduli District.

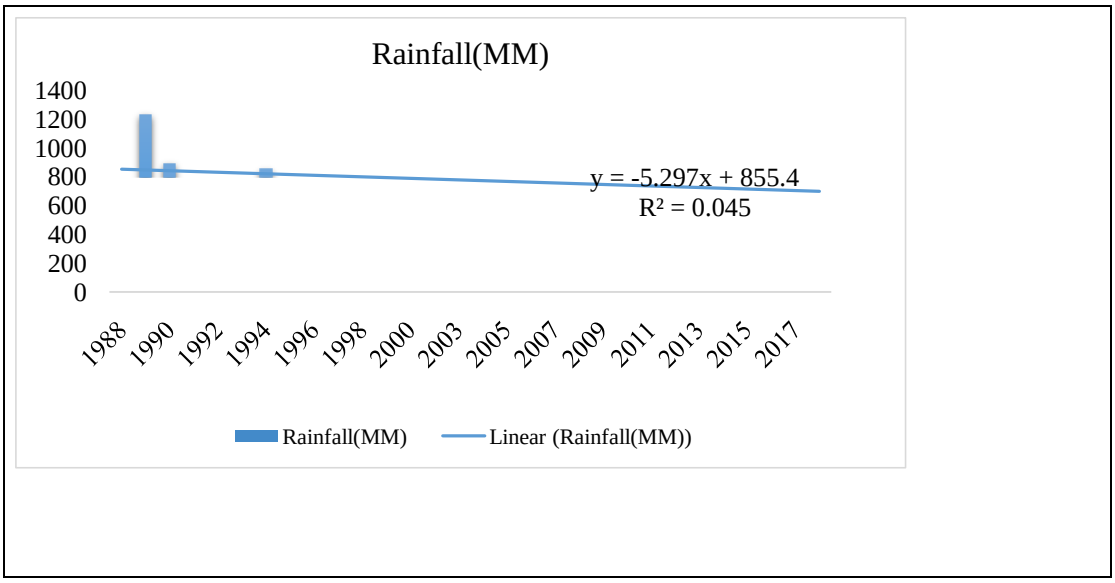


**Figure 4.5: Rainfall Trends in Monduli District**
**Source:** Research Data from TMA, Arusha Airport, 2019

The data plot as indicated by Figure 4.8 demonstrates that the district had been experiencing fluctuations in rainfall activity from 1988 to 2018, as evidenced by fluctuations in the solid line. The curve demonstrates that the district received a minimum of 398.1 mm of rain and a maximum of close to 1225.6 mm during the period. Generally, it can be said that the district had experienced both high and low rainfall activity over the period. In terms of the period trend, represented by the linear regression line, the line shows a marginal fall in rainfall from 1988 to 2018.

Largely, the regression line has a continuous downfall for the whole period indicating that the district has experienced dramatic fluctuations in rainfall activity during the research period

Results of this study on rainfall decline is also supported by Kimaro (2018), who reported that Monduli district has experienced significant fall in rainfall amount that is deviating from average annual rainfall that led to an area experience of severe scarcity of water and pasture. The climate change strategy of Tanzania, URT(2012) also declares that Arusha is one of the areas that have experienced increases in mean rainfall and increased rainfall variation with extended dry season periodand increase in reduced water sources.

Also from the results and responses on the rainfall variable show that Monduli district has experienced rainfall patterns characterized by both decrease in rainfall activity (below average rains) as well as increases (above normal rains). The general rainfall trend for the district shows that a significant change in rainfall pattern has occurred over the period. This rainfall pattern characterized by inter annual variations has been associated with dry and wet spells and this corresponds with URT (2012), which reported that the country has experienced an increase in drought spells as evidenced by the droughts of 2003, 2005 and 2009 severely affected agriculture, energy and business sectors in Tanzania.

Agriculture has been destroyed in the affected areas; many animals and wildlife have died as a result of starvation and lack of water. Tanzania suffered a severe energy crisis amid these droughts, with significant social and economic consequences.

Furthermore, these findings are also consistent with IPCC (2007) which reports that inter annual rainfall variability is large over most of Africa. An increased inter-annual rainfall variability was reported in Africa in the post-1970 period, with higher rainfall anomalies and more intense and widespread droughts, which many scientists attributed to long-term climate change.

### 4.3.2 Perceptions on Rainfall Trends

Views were also sought from the households regarding rainfall patterns in their areas. The study asked the respondents to state what they had observed about rainfall from three perspectives, namely; quantity of rainfall in a year, whether has increased and the overall rainfall trend. The perceptions noted from the responses were based on whether households indicated that these aspects had increased, decreased or there was no change (rainfall had remained the same).

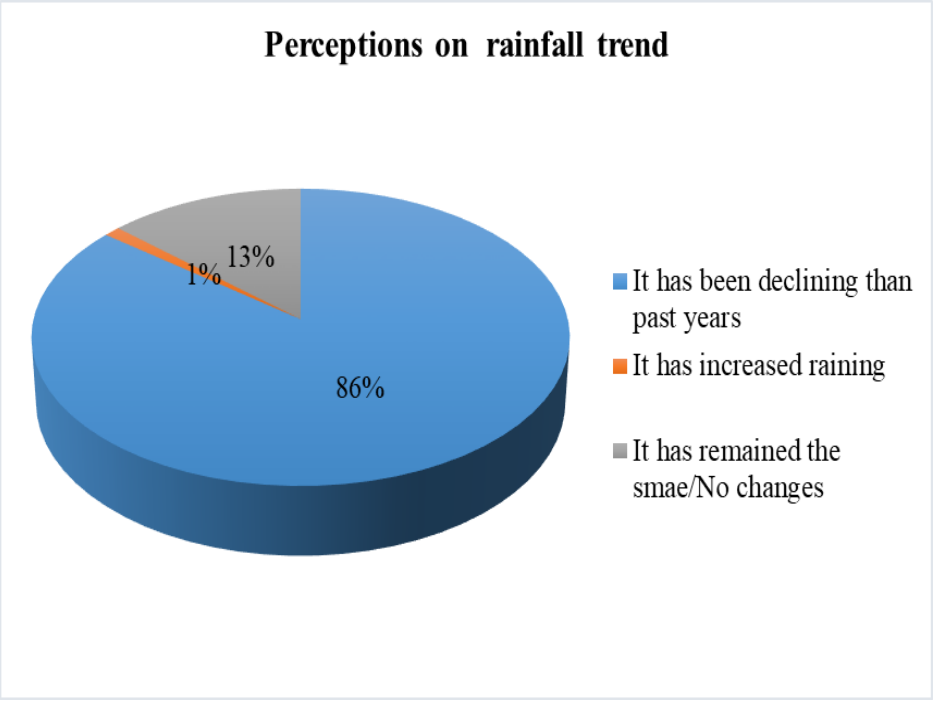


**Figure 4.6: Perceptions on Rainfall Trends**
**Source:** research data, 2019

Based on the responses from figure 4.6, 86% of respondents declared that they have been observing a decline in annual rainfall and, 13% noticed no changes in rainfall trend whereas only 1% noticed increase in rainfall. Therefore, indicated that the rainfall is not enough to sustain crops and that they are noticing a continued downward trend in the number (frequency) of rainy days in the rainy season as well as lower amounts of total precipitation. All the respondents reported that the frequency and length of these droughts had increased.

One of major examples of these scenarios according to the respondents was that from the 2008-2012 seasons, there was very little rainfall which and resulted in lots of crop failures, an increase crop disease and an increase cattle mortality. In In-depth interviews, respondents were asked whether Monduli is facing climate change, and some respondents replied by describing the troubling changes in climate factors such as decreases in rainfall, short and erratic rainfall seasons, increasing surface temperatures and prolonged drought cycles. This was painted by some quotes below from various in-depth interviews;

> "*There is no enough rainfall and also, we are not experiencing the normal rainfall calendar as we used to .It may even not rain. For example this year it did not rain according to usual calendar but at the end it rained heavily in a very short time, so it has decreased and if it rains, may rain in a very short time"( Village elder, Makuyuni village).*

> *"Decline in seasons of rainfall has taken place over ten years ago for example in 2007/2008 we started experiencing disasters related to lack of rainfall. We used to have enough rainfall but as time goes, it is declining, I don't know what will be the station in the next years because everyday rainfall is declining or rain in a very short time" (Former village leader, Mswakini village) records* from TMA demonstrate that in the Monduli district there was a continuous decline in annual rainfall from 2008 to 2012 from 837.5 mm to 518 mm.

Since Monduli is found in Arusha, asupportive secondary data obtained from Kihupi(2015), on the study on Trend of Growing Season Characteristics of Semi-Arid Arusha in Tanzania, determined the rainfall pattern during the main growing season to show how onset and cessation are behaving . In this study it shows that Seasonal rainfall and annual rainfall of the area is declining despite the insignificancy of the trend. Growing season are changing, turning into poor production. This implies that amount of water source available is insufficient to support the demand which requires new adaptation alternatives.

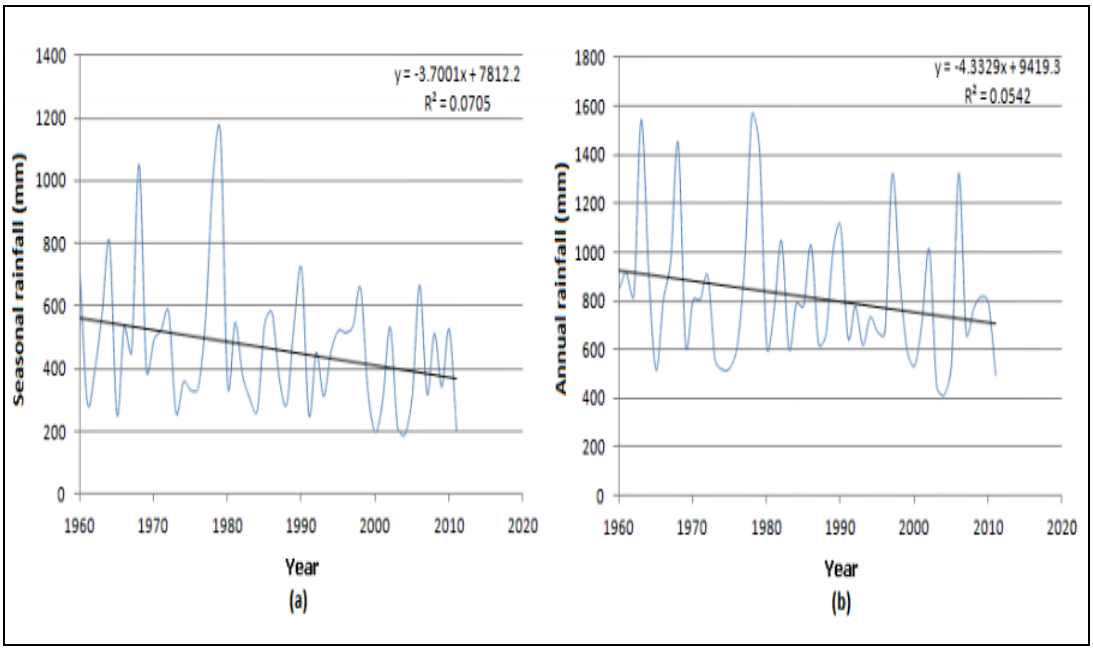


**Figure 4.7: Trend of Seasonal Rainfall Pattern during the Main Growing Season**
**Source:** KIHUPI, (2015)

From the figure above, shows the declining in seasonal rainfall and annual as well , also the study indicates that dry spells are increasing in growing seasons where as there are high probability of having more than 7 days of dry spells during the growing seasons, that has not been like that in the past (Kihupi, 2015).

### 4.4 Temperature Trends in Monduli District from 1988 to 2018

To determine the trends in temperature over the period 1988 to 2018, the Mean maximum and minimum annual temperature data for the district, were presented in a graph as shown in figures below. The mean maximum and minimum annual temperatures were calculated from the average monthly temperatures and therefore represented the average temperature for each of the years under review.

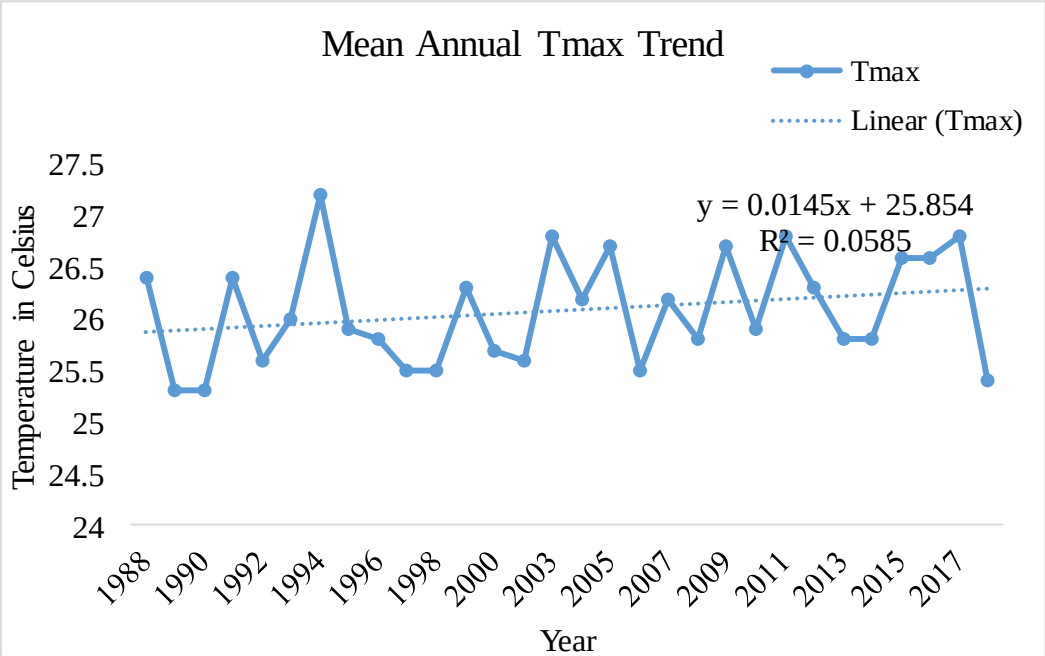


**Figure 4.8: Maximum Temperature Trends in Monduli District from 1988 to 2018**
**Source:** Research data from TMA Arusha Airport, 2019

From figure 4.8 above, maximum temperature is increasing in the area although it is not significant with *P.171*, which need more research in the future. For this annual maximum temperature, the rainfall has a positive correlation, that is, temperature is increasing with time (1988-2018) which is identified by its linear slope. In some years the area experienced inter annual temperature variations while other years they had consecutive uniform mean annual temperatures, for example 1989-1990, 1997-

1998 and 2015-2016 respectively had uniform maximum temperature variations.The graphs demonstrates the district has experienced the mean maximum annual temperatures ranging between 25.3$^0$C and 27.2$^0$C, implying that Monduli is experiencing an increase in surface temperature that has impact on various resources such as water and vegetation , as reported by URT,2012 Monduli district is among areas continuing to experience high temperature levels

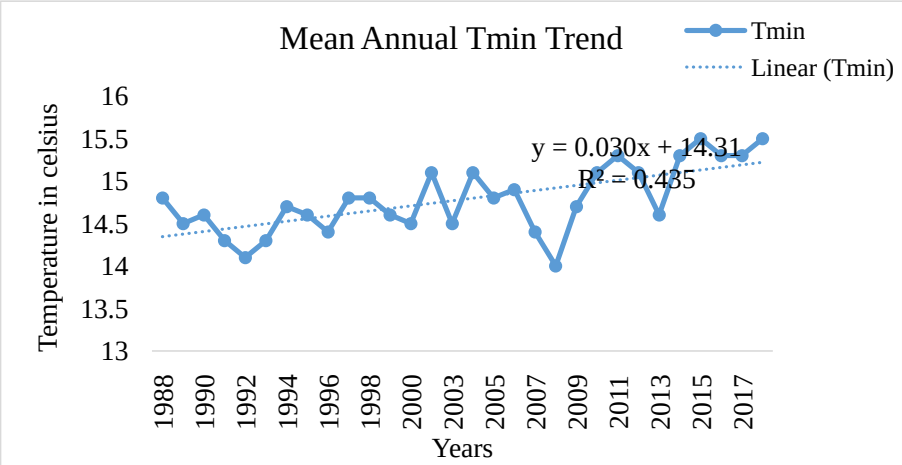


**Figure 4.9: Minimum Temperature Trend in Monduli District1988 to 2018**
**Source:** Research data from TMA Arusha Airport, 2019

For analysis of mean annual Tmin reveals a positive correlation of increasing temperature trends in Monduli district though it is not significant at *P.179*. Figure 4.9 depict minimum annual temperature trends for Monduli. The mean annual Tmin trend is more pronounced in compared to mean annual Tmax. This is also expected to increase with time in the area (URT, 2012). The plot also demonstrate that at some time, the district had experienced both rises and falls in minimum annual temperature. The graph demonstrates the district had experienced the mean of minimum annual temperatures ranging ranged between 14.0$^0$C and 15.5$^0$C. The

linear regression line shows that the curve is rising for the whole period. This rise in the regression line indicates that the temperature had been increasing in the district during the whole period.

### 4.4.1 Perceptions on Temperature Trend

To examine the level of experience in increase of surface temperature in Monduli district, the study asked respondents perceptions on how they felt on the level of temperature. Results are presented in Table 4.4.

**Table 4.4: Perceptions on Temperature Trend**

| Surface temperature has increased | Frequency | Percent |
|---|---|---|
| Yes | 307 | 85 |
| No | 55 | 15 |
| Total | 362 | 100 |

**Source:** Research data, 2019

From the Table 4.4, sampled households on their observations regarding the surface temperature trends in their areas, the respondents provided diverse reactions, with 85% reporting that the surface temperatures in the area had increased, while 15% reported that it had not increased. When asked about the trend of temperature in the area, respondents admitted to have experienced an increasing surface temperature that has impacted the community in different ways. Two of the interviewee had the following to say about temperature trend.

> "*The temperature has been increasing every day, glasses are getting dry, no pastures for animals, rivers and dams are getting dry, and crops are drying so it is a very big problem. Before it was not like this today as you can even see by yourself, everything is dry the land is bare no glasses, it is just dry sand"(Senior elder, Esilalei Village).*

*" The amount of temperature is truly increasing in our area and as this has really affected our people , they only depend on their land to feed cattle, sell them and obtain money but now it's hard because the land is very dry, the dry spell periods are longer than wet seasons so there is longer suffering in the area and even if it rain it rains shortly that the land cannot hold water for vegetation to grow because the land has been very dry over long time , hence water is soaked into the ground when it rains, hence the amount of temperature is very extremely high in Monduli"( Extension officer, Makuyuni ward)*.

Through the study observation the area indicates to have dry land that has been affected by increased surface temperature with no rains and causing land to loose vegetation .Figure 4.10 shows how vegetation cover of the area has been affected by increased surface temperature and declined rainfall

**Figure 4.10: Loss of Vegetation Cover at Makuyuni Village**
**Source:** Research data, 2019

### 4.5 Climate Change Impact on Food Security

To measure climate change impact on food security in Monduli, the household food security status was determined on the basis of four main questions which were; the households perceptions on their situation based on whether they were having enough, moderate or not enough food, and whether the food production had

increased, decreased or there was no change, their ability to buy food as well as their number of meals per day. Internationally recognized number of meals an adult should have in a day is three, and it is on such bases that these indicators were used.

### 4.5.1 Households' Perceptions on Food Security

In order to find obtain information on household food security through production of food, respondent were asked to state the status of food production whether they produce enough, moderate or not enough food since food availability is one of measure for food security.

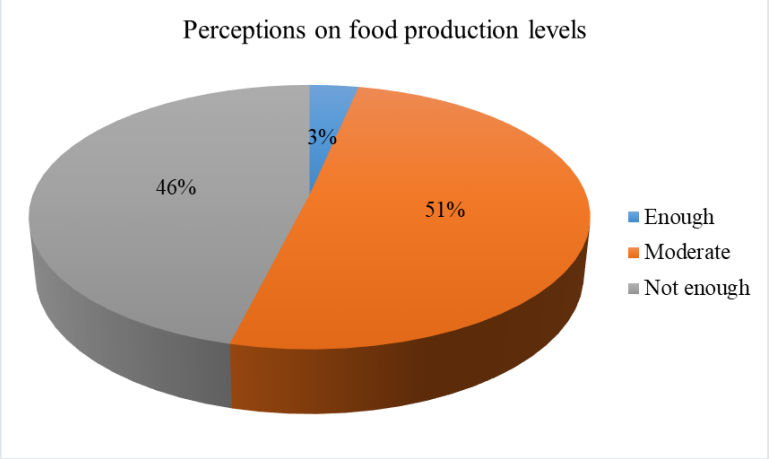


**Figure 4.11: Perceptions on Food Production Levels in Monduli**
**Source:** research data, 2019

As the results shows from respondents, recommends that the area is facing food shortage as 51% have experienced moderate food production while 46% have not enough food and only 3% have enough food. Having enough food is contributed by the family effort to have petty business, selling cows and buying stock of food for reselling them to the community where the demand is higher because majority have to buy food, some households have farms in other places away from the district where it rains and they grow food over there, that is where they also obtain food

from.

But majority who have continued with keeping herds of cattle for prestige they have no food, and they land can't offer anything as its dry and cattle dies hence tye can't sell their very weak cattle because they have no market and they can't get money to buy food also they have no farms in other places. From the status of food production, having such a wide incidence of food insecurity level in the households indicates that the area is suffering from an insufficiency of food access. If the household has no enough security then it lowers man power as well for food production which continues to suppress the level of food security in the family.3.

### 4.5.2 Perceptions on Trend of Food Production

The study also aimed at getting more information about the trend of food production at the household, respondents were asked based on their perceptions on time of experience in the area in comparison with trend of food production levels whether increasing or decreasing or no changes. Results were summarized as shown in the figure below.

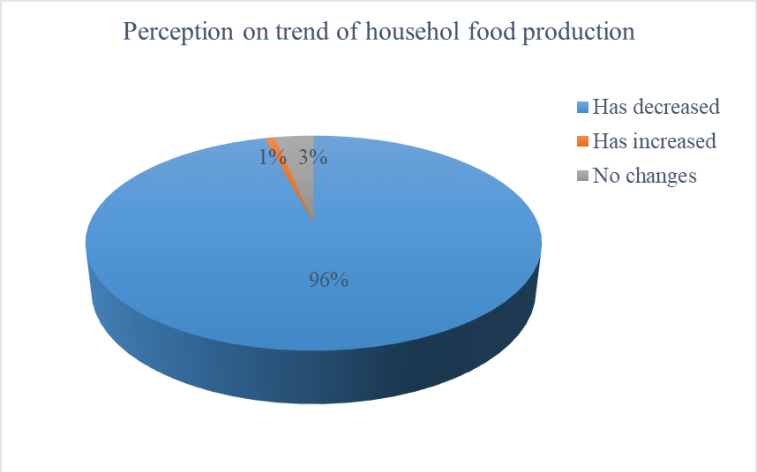


**Figure 4.12: Perception on Trend of Household Food Production**
**Source:** Research data, 2019

From the study shows that 96% of household heads declared that food production has decreased and only 1% has observed an increase and this has been due to the family having land elsewhere doing farming activities and doing petty business like shops, where as 3% suggested to have observed no changes in food security. Such evidence from the study from household responses implies that there is an increase in food insecurity in Monduli district. It is apparently shown that the trend of food production and quantity is declining which is a great concern to the community and their ability to obtain enough food.

This food security situation confirms literature on the fact Northern Tanzania is one of the areas at risk (URT, 2012). This food insecurity in northern Tanzania households is linked to the fall in production of crops, and animal production. During interview sessions it was interesting that respondent explained how some families have observed food production increase and the rest also explained with strong feelings how bad they are food insecure as quoted below

> "*In this area majority grow maize which is our main dietary food, but the situation has changed we cannot produce food like we used to in the past years, let us say about 20 years ago we were having enough food produced from our own farms, we never used to have may shops for food in our communities because we had food but thing have changed a lot we have to buy food because we can produce food , the land is very dry and therefore because the income is not good we have less than required food in the families, sometimes only expectant mothers, grandparents and children are the one that have to eat while grown up ones skip meals(senior female elder, Esilalei village).*
>
> *"It is true that we have no enough food but some of our families have farms away from this area, we do farming there and get food from such farms because over such area there is rainfall than here and some like my son has a shop for selling food here in this community , we sell food to many people because most of people have not harvested , so for my family we have enough food, you have to tell the government to tell our people to also do business because there is no rain but if they do like my son selling cows and buying stock of food to sell later buy cows when they are health, we will have food even in hard time" (senior elder , Mswakini village).*

### 4.5.3 Household's Ability to Afford Buying Food

The study also eagerly wanted to examine the ability of the household to purchase food considering the fact that climate change on food security deceases food availability as shown in figure 4.11 above. When it comes to ability to afford buying food as the area is facing climate variations that affect food production, only 15.5% have the ability to afford buying food whereas it is a very hard situation for 84.5% of the households who indicated their income that is insufficient to afford buying their own food.

**Table 4.5: Households Ability to Buy Food**

| Can afford to buy food | Frequency | Percent |
|---|---|---|
| Yes | 56 | 15.5 |
| No | 306 | 84.5 |
| Total | 362 | 100 |

**Source:** Research Data, 2019

As the majority (85%) are not able to buy food, it apparently implies that majority of the households have no enough meals because they have no cash to buy food. Kimaro (2018) determines that a pastoral communities in Monduli obtain food from cattle by selling them and buy food, hence with this situation the community is very vulnerable to climate change as cattle fails to have good health status to be sold and many of them die which have no markets for selling, remaining the families with no option to have food rather than skipping or having less that required number of meals. The poor growth of cattle due to lack of pasture, which normally the households sell in order to obtain food. Therefore, when there are not enough pasture experienced during with high levels of both droughts and floods, the economic stability of the households is at risk which leads to an increase in their food

insecurity.

### 4.5.4 Number of Meals per Day

Number of meals per also determines the level of food security at the household (the international recommended number of meals per day is three). Food access is also determined by the household's ability to afford buying food. The figure below demonstrates the household meals per day and their ability to buy food. The figure below above shows that 71% can afford to have only two meals per day, whereas 11% can only afford one meal per day, and only 18% can afford to have access to three meals per day.

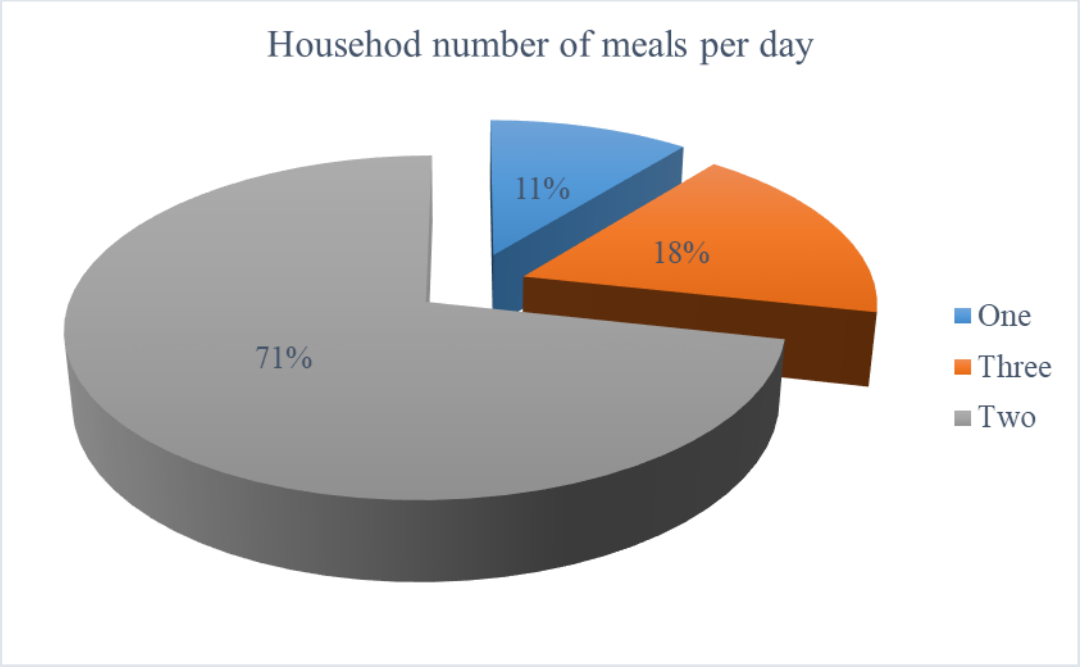


**Figure 4.13: Household's Number of Meals per Day**
**Source:** Research data, 2019

From the results figure above and perception, respondents are worried about their household food security situation. As majority can afford two meals per day but the 11% who can afford only one meal per day suffer a lot, this is part of community

who have no enough cows that they can sell and get food, have no enough manpower especially youths and have no enough land, they are found of skipping meals except children, seniors and expectants. Interviewed households' heads declared that they were food insecure as the dominant environment did not support a secure status. It is evidently seen that household are continuing to get concerned and worried of the changing patterns with their household food situation. With this fact Monduli is recognized to be at risk of food insecure because according to FAO (2016) climate change impact on food production has caused shortages in households hence reducing number of meals per day, eating two meals a day.

### 4.6 Perceptions on Seasonal Changes and its Impact on Food Security

To determine the perceptions on climate seasonal changes impact crop production in Monduli districts; the study used three perspective measures which are; 1.). Determining whether there are seasonal changes affecting crop production and access and availability access and 3.) Perception of the impact of seasonal changes on household food availability.

#### 4.6.1 Seasonal Climate Changes and Crop Production

The study interviewed household heads to determine the effect of seasonal climate change and its impact on household food security through their perspectives. The figure below demonstrates the perspectives of households on the existence of seasonal changes on crop production. In this study, 66% of the respondents indicated that there has been seasonal change impact on crop production whereas 34% reported to have observed no seasonal change impact on crop production.

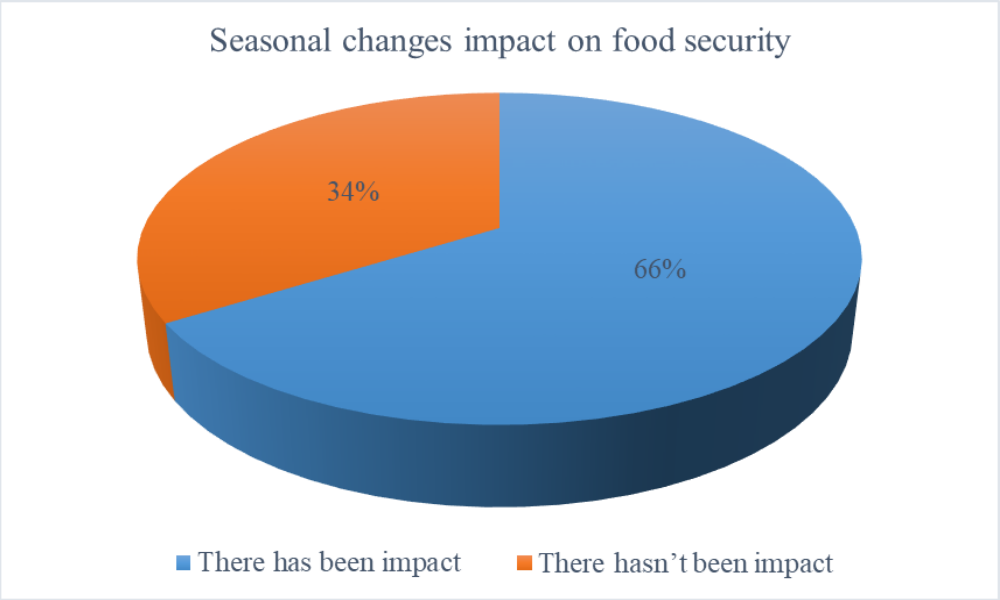


**Figure 4.14: Perspective on Seasonal Changes Impact on Crop Production**
**Source:** Research data, 2019

Results from the figure above implies that majority of the households in the area are facing food fluctuations due to changes in seasons for crop production. Kihupi(2015) discusses changes in growing seasons due to climate change that is, onset and cessation affects human life through food security and their livelihoods. Specifically to semi-arid areas similar to Monduli are facing such constraints. From respondents views they have a concern on onset and cessation and length of rainy season, because of increase in dry spells in the growing seasons. As a result of this it affects their agricultural timings that has led to food shortage in Monduli area.

### 4.6.2 Seasonal Changes Impact on Food Access

To examine the impact of seasonal changes on food access the study interviewed respondents to obtain their perceptions. Respondents were able to give out their perceptions on how the changes in seasons due to climate change have affected food access in Monduli. The table below demonstrated the findings.

**Table 4.6: Perception on Seasonal Changes on Food Access**

| There are seasonal changes impact on food access | Frequency | Percent |
|---|---|---|
| Yes | 289 | 79.8 |
| No | 73 | 20.2 |
| Total | 362 | 100 |

Source: Research data (2019)

As the Table 4.6 shows there have been seasonal changes impact on food access in the area, only 20.2% report being able to access enough food, whereas 79.8% have experienced insufficient food access during seasonal changes. This implies that over 50% of the people in Munduli district are food insecure due to climate changes that directly affect growing seasons which has affected them to have less or no access to enough food, and because food access is one of the major components of food security, the community is termed to be at risk of nutritional diseases such as Scurvy, Rickets, Beri Beri, Hypocalcemia, Osteomalacia, Vitamin K Deficiency, Pellagra, Cheilosis, Menkes Disease, Xerophthalmia which has also been discussed by FAO (2017).

### 4.6.3 Impact of Seasonal Changes on Food Availability

Findings from the study demonstrate that 99% of respondents declared that seasonal changes have decreased their household food availability, whereas only 1% have not observed impact on food during such seasonal changes. From the Figure 4.15 it implies that since seasonal crop production changes have occurred, many households are faced with fluctuations in cash flow and income, both within one year and from year to year. Agricultural households may face seasonal income fluctuations due to

the impact of climate on crop cycles. Continuous and prolonged income fluctuations can result from varying agro-climate and climate change conditions.

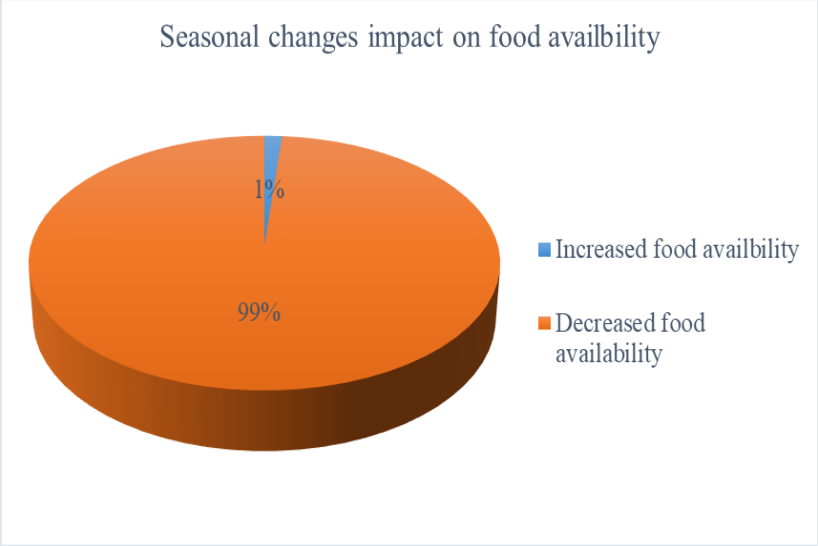


**Figure 4.15: Seasonal Changes Impact on Household Food Availability Source:** Research data, 2019

Kimaro (2018) and Maleko & Koikapi (2015) address that in many areas of local food production and consumption, food utility varies with seasonal variations and changes in food availability throughout the year. Nevertheless, those who have continued to have access to food are characterized by having more than one source of income, such as food shops, owning farms outside Monduli, so the food they get is not grown in the district. The season of hunger is the time before the crops are ready to be eaten. All the two studies centered on the situation of Monduli district in semi-arid areas of northern Tanzania.

# CHAPTER FIVE

# SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

## 5.1 Introduction

This chapter presents the study summary of the study's findings, discussion, conclusions, recommendations and offers suggestions for further research. The findings are summarized in line with the objectives of the study, which was to assess the impact of climate change on food security in northern Tanzania, a case of Monduli district. The results of the study were presented in the previous chapter.

## 5.2 Summary of the Findings

The first objective was to examine the trends of rainfall and temperature as potential evidence of climate change in Monduli district. The results showed that the amount of rainfall has been declining. The rainfall pattern suggests that the area may be expected to receive decreasing amount of rainfall as time goes. This is also discussed in the United Republic of Tanzania climate change strategy of 2012. The impact of temperature changes is increasing both mean annual maximum (Tmax) and minimum temperature (Tmin).

From the results implies that both Tmin and Tmax are at an increasing rate which is another apparent sign of global warming 96% of respondents declared that food access has decreased where as 84.5% have no ability to afford buying food and only 15.5% are able to buy food. Though 71% households afford to have only two meals per day, where as 11% get one meal per day and only 18% have access to three meals per day (the internationally recommended number of meals per day).

The third objective was to examine household perceptions on seasonal climate changes and their effect on food security in Monduli district. It was found that 66% of households reported that there have been seasonal changes impact on crop production and food security whereas 79.8% indicate to have observed seasonal changes impact on food access, but, and 99% of households declared that seasonal changes have decreased food availability. However, household level of awareness to climate change is low with 62.4% households reporting to have not heard of or received advice related to climate change by agricultural extension officers. A minority, only 37.6% have heard of and have access to knowledge about climate change.

### 5.3 Conclusions

This section presents the conclusions made in the study. The study determines that the Monduli community is facing climate change extremes which affects their livelihood. Further, this means that the area is at risk from climate change and also implies that the Northern Tanzania is affected and also at risk from climate change. Research objective one (1) examined the trends of seasonal rainfall and temperature as evidence of climate change in Monduli district. The study found that through a 30-year period (1988-2018) that the climate of Monduli is changing and the rainfall amount is continuing to decline although there are some variations in the climate patterns. The area has experience increasing minimum and maximum temperature levels which are resulting in loss of water sources and vegetation cover in the area.

The second objective was to examine the trends in food security (access, use and availability) as a function of normalized income. The study established that there is

not adequate food security in area due to low income levels experienced by majority of households, who are not able to afford to buy food and that the number of meals per day are limited with majority of the population are not able to access three meals in a day.

The third objective was to examine perspectives on seasonal climate changes and its effect on food security in Monduli district. Household's perspectives indicate that there is an observed change in seasons that affect crop production which in turn lead to fluctuation of food security for the households. This creates loss of hopes for getting food in the area because of unsurely climate factors.

### 5.4 Recommendations of the Study

i. With reference to study objective one (1), the amount of rainfall amount is declining with increase in annual mean maximum and minimum levels of temperature, the northern Tanzania area is in climate change risk which needs immediate and active collaboration between local extension and livestock officers in Monduli, climatological departments in Arusha, local community based NGOs in Arusha that extends to local level to provide up to date information for help farmers adapt to climate change. For example, training farmers and livestock keepers in Monduli on farming calendars. Crop recommendations which are able to withstand and grow well in the face of climate change patterns and access to crop production advice, this will make a participatory agricultural transformation to adapt to climate change and enable household food security.

ii. Objective (2) aimed at examining the trends in food security (access, use and availability) as a function of normalized income. From the results, the community is facing shortage of food access and availability, decline in number of meals per day, there is a need for alternative supportive income generation activities in Monduli community apart from cattle, in order to support household ability to save money or buy food when the crops fail and cattle die and/or when they have no market access to sell cattle so as to obtain food. Such alternative livelihood support programs need to have needs assessment and situation analysis before implementation so that to introduce what fits and acceptable in the community of Monduli, and should also be participatory that is; involving people from the grassroots. This will help into easily adoption of such methods by the people without altering their culture and values which is very significant in Monduli community of majority Maasai.

iii. Being the third objective, examining perspectives on seasonal climate changes and its effect on food security. In order to copy with changes in growing seasons that has changed onsets and cessation of rainfall which have eventually fluctuated food production at household level. Environmental policy and institutional arrangements to take advantage of improved technologies which are alternatives to support community resilience to climate change is highly needed in the area. This should be accompanied with establishment of short term growing crops that correlates with nature of length of rainfall in the area. This need to be done through demonstration farms, in villages, that should apply both old and new improved crops so that farmers should learn by doing

and decide by observing differences of two simultaneously crops cultivated in the same plot but practically different, hence such farmers will learn, like and train others and finally own the method in practice. It should be participatory approach. Therefore the Tanzania Agricultural ministry should enable such collaboration with Tanzania Agricultural Research Institutes (TARI), Community Based organizations that are dealing with food security in Monduli such as World vision Tanzania, Research Community and organization Associates and others.

## 5.5 Suggestions for Further Study

It is noted that this research was confined to the impact of climate change in Northern Tanzania through a case of Monduli district. The researcher suggests the following to be considered for further research:

i. Similar studies should be done in other districts and regions and also in other agricultural and livestock sectors and in order to broaden the ability of communities to adapt to climate change.
ii. A comprehensive research focusing on food, cattle and income should be conducted along similar period of time (30 years and above) to establish more relationship of the variables so that to create supportive interventions can be made in response to climate change impacts in the communities
iii. There is need to carry out research on the factors influencing the adaptation to climate change especially in nomad societies.
iv. Research on climate change that are done should be made in easily available and understandable reports for the local community where they are conducted and not be just kept in offices, this is very important, unless it is done, small

holder farm communities will adequately be unable to adapt to climate change.

Further researches have to be conducted involving more climate factors more than 30 years to examine level of significance which has been not significant in this study.

## REFERENCES

Adler, E. S. (2011). *An invitation to Social Science Research; How It's Done.* Belmont, CA: CENGAGE Learning.

African Development Fund (ADF), (2003). Monduli District Water Project Appraisal Report, African Development Fund. Monduli, Tannzania, ADF.

Almalki, S. (2016). Integrating Quantitative and Qualitative Data in Mixed Methods Research; Challenges and Benefits. *Journal of Education and Learning,* 5(3), 288-296.

Bryman, A. & Bell, E. (2011). *Reliability and validity in qualitative research.* Paperback: Sage.

Chang'a, K. & Mtongori, N. (2017). Spatial and Temporal Analysis of Rainfall and Temperature Extreme Indices in Tanzania. *Atmospheric and Climate Sciences.* 7, 525-539.

Cochran, W. G. (1963). *Sampling Techniques*, 2nd Ed., New York: John Wiley and Sons, Inc.

Crate, S. A. (2011). Climate and culture: Anthropology in the era of contemporary climate change. *Annual Review of Anthropology*, 40, 175-194.

Dasgupta, P. Ramanathan, V. Raven, P. Sorondo, Mgr M., Archer, M., Crutzen, P., Lena, J., Lee, Y. T., Molina, M. J., Rees, M., Sachs, J., Schellnhuber, J. (2015). Climate Change on Common Good. Synthesis Report, The Pontifical Academy of Sciences and the Pontifical.

Douglas, M. (1966). *Purity and Danger: Analysis of concepts of pollution and taboo.* 2, 88. London: Routledge.

Ellis, F. (2003*). Livelihood and Rural Poverty Reduction in Uganda, Elsevier*, 31(6), 997-1013.

Food and Agriculture Organization (2016). *The State of Food and Agriculture.* Flagship publication, Rome: FAO.

Food and Agriculture Organization (FAO) & UN. (2008). Climate change and food security, a framework document, a report of high level panel. Rome: FAO.

Food and Agriculture Organization (FAO) (1990). The state of Food and Agriculture; World and Regional Reviews Structural Adjustment and Agriculture. FAO Agriculture Series No. 23. Rome, Italy.

Food and Agriculture Organization (FAO) (1996). Rome Declaration and World Food Summit Plan of Action. Rome, Italy.

Food and Agriculture Organization (FAO) (2005). Impact of Climate Change, Pests and Diseases on Food Security and Poverty Reduction, Background Document, FAO.

Food and Agriculture Organization (FAO) (2006). *The state of Food and Agriculture.* Rome: Electronic Publishing Policy and Support Branch.

Food and Agriculture Organization (FAO) (2007). Adapting to Climate Change. Interdepartmental Working Group, Rome, Italy.

Food and Agriculture Organization (FAO) (2013). The State of Food Insecurity in the World, The multiple dimensions of food security. Rome.

Food and Agriculture Organization (FAO) (2017). Africa Regional Overview Food Security and Nutritional Report. Rome: FAO.

Food and Agriculture Organization (FAO), (2018). Report on Regional Africa overview of food security and nutrition, addressing the threat from climate

variability and extremes for food security and nutrition. Italy: FAO.

Food and Agriculture Organization (FAO), (2018). The State of Food Security in the World. Rome, FAO.

Food and Agriculture Organization (FAO), (2019). The State of Food Security in the World, Rome, Italy.

Foresight, K. U. (2011). The future of food and farming. Final Project Report, London: the Government Office for Science.

Heather, E. T. & James, D. F. (2010). Climate Change and Food Security in Sub-Saharan Africa: A Systematic Literature Review. *Journal of sustainability*, 2(8), 2720-2723.

Hulme, M. (1996). Climate Change and Southern Africa: An exploration of Some Potential Impacts and Implications in the SADC Region. Norwich, University of East Anglia: Climate Research Unit.

Hulme, M., Arntzen, J., Downing, T., Leemans, R., Malcom, J., Reynard, N., Ringrose, S., Rogers, D. (1996). Climate Change and Southern Africa: An Exploration of Some Potential Impacts and Implications for the SADC Region', report prepared for WWF International: Climatic Research Unit, UK.

Intergovernmental Panel on Climate Change (IPCC), (2007). Climate Change 2007 – Impacts, Adaptation and Vulnerability; Contribution of Working Group II to the Fourth Assessment.

Intergovernmental Panel on Climate Change (IPCC). (2012). Managing the risks of extreme events and disasters to advance climate change adaptation. A special report of the intergovernmental panel on climate change.

International Food Policy Research Institute (IFPRI), (2010). Climate Change Impacts on Food Security in Sub-Saharan Africa.

International Food Policy Research Institute (IFPRI). (2019). Agriculture and food security. Washington D.C: IFPRI.

Jones, D. (2001). Adjusting for sampling density in grid-box land and ocean surface temperature time series.

Kahimba, F. C. (2015). Climate Change and Food Security in Tanzania: Analysis of Current Knowledge and Research Gaps. Morogoro.

Kamara, A. B. (2009). Soaring food prices and Africa's vulnerability and responses: an update. Working Papers Series No. 97, p. 36.

Kaswamila, A. (2017). The pastoralists' resilience and innovative adaptation strategies on impacts of climate change in rangelands of Longido District, Tanzania. Natural systems in changing climate, 341.

Kihupi, N. (2015). Trend of Growing Season Characteristics of Semi-Arid Arusha District in Tanzania. *Journal of Agricultural Science*, 7(9), 47-52.

Kimaro, E. G. (2018). Climate change perception and impacts n cattle production in pastoral communities of northern Tanzania. *Pastoralism*, 8(19), 1-10.

Kothari, R. C. (2004). *Research methodology: Methods and techniques.* New Delhi: New Age International.

Magadza, C. (1996). Climate Change: Some Likely Multiple Impacts in Southern Africa, In Climate Change and World Food Security, Conference Paper No. 37.

Maleko, D. D & Koipapi, M. L. (2015). Opportunities and constraints for overcoming dry season livestock feed shortages in communal semi-arid

rangelands of Northern Tanzania: A case of Longido District. Livestock Research for Rural Development.

Mkonda, M. Y. (2018). Comparing Smallholder Farmers' Perception of Climate Change with.

Munishi, P. (2009). Analysis of Climate Change and its Impacts on Productive Sectors, Particularly Agriculture in Tanzania.

Mwakaje, A. G. (2013). The Impact of Climate Change and Variability on Agro-pastoralists Economy in Tanzania. .

National Bureau of Statistics (NBS). (2012). Population Distribution by Age and Sex, National bureau of statistics.

Ngulube, P. (2005). Research procedures used by Master of Information Studies students at the University of Natal in the period 1982–2002 with special reference to their sampling techniques and survey response rates.

Oppenheimer, M. (2017). Assessment of Social Vulnerability to Climate Change at the Local Scale Development and Application of a Social Vulnerability Index. An Interdisciplinary, International, Journal Devoted to the Description, Causes and Implication of Climate Change, 1-5.

Osborne, J. W. & Costello, A. B. (2004). Sample size and subject to item ratio in principal components analysis. Practical assessment, research & evaluation.

Salma, salahudin & Alia. (2017). Climate Change: A Review of the Current Trends and Major Environmental Effects.

Saringe, E. (2011). Impact of Climate Change to Pastoralists and Hunters Gathering Communities of Tanzania. A Case Study of Kiteto and Simanjiro Districts, Tanzania.

Schmidhuber & Tubiello. (2007). Global food security under climate change. Proceedings of the National Academy of Sciences of the United States of America.

Shemsanga C, Nyatichi .A and GU. Y. (2010). The Cost of Climate Change in Tanzania. Impacts and Adaptations. *Journal of American Science* (1545-1003), 182-196.

Skovdal, M. (2015). *Qualitative Research for Development: A guide for practitioners.* Warwickshire: Practical Action Publishing.

Theodory, T & Malipula, M. (2014). Climate change and socio-economic vulnerability among Maasai pastoral communities in Northern Tanzania. *Journal of Policy and Leadership,* 2(10), 20-22.

Thomas, T. S. & Waithaka, M. (2013). East African Agriculture and Climate Change: A Comprehensive Analysis-Tanzania; IFPRI: Washington DC USA.

Tim Wheeler and Joachim. (2013). Climate change impact on Global Food security.

Tol, R. (2009). The economic effects of climate change. *Journal of Economic Perspectives,* 23(2), 29–51.

United Nations development Program (UNDP). (2012). the Nutrition Challenge in Sub-Saharan Africa.

United Republic of Tanzania (URT). (2011). the Economics of Climate Change in the United Republic of Tanzania.

United Republic of Tanzania (URT). (2017). Comprehensive Food Security and Nutrition Assessment Report. Dar es Salaam, URT.

United Republic of Tanzania, (2012). National Climate Change Strategy; Division of Environment. URT.

Wambua, B. N. (2008). Food Security in Semi-Arid areas.

World Meteorological Organization (WMO). (2005). Statement on the status of global climate change. Geneva, Swiss.

World Meteorological Organization, UNEP and UNESCO. (2005). Facing the Facts: Assessing the Vulnerability of Africans Water Resources to Environmental Change, WMO.

# APPENDICES

TOOLS FOR DATA COLLECTION

| SECTION A: HOUSEHOLD CHARACTERISTICS | TICK |
|---|---|
| VILLAGE OF RESIDENCE | |
| 1. Mswakini | |
| 2. Makuyuni | |
| 3. Esilalei | |
| SEX | |
| 1. Female | |
| 2. Male | |
| MARITAL STATUS | |
| 1. Single | |
| 2. Married | |
| 3. Widow | |
| AGE RANGE (YEARS) | |
| 1. 18 – 27 | |
| 2. 28 – 37 | |
| 3. 38 – 47 | |
| 4. 48 – 57 | |
| 5. 58 – 67 | |
| 6. 68–77 | |

| LAND OWNERSHIP TYPE | TICK |
|---|---|
| 1. Inherit | |
| 2. Bought | |
| 3. Rent | |
| MAIN ECONOMIC ACTIVITY | |
| 1. Farming | |
| 2. Agropastoral | |
| 3. Pastoral | |
| What is your family's monthly Income? | |
| 1. 0-490000 | |
| 2. 50000-99000 | |
| 3. 100000-1490000 | |
| 4. 150000-199000 | |
| 5. 200000-249000 | |
| 6. 250000-299000 | |
| 7. 300000 and above | |
| HOUSEHOLD WATER SOURCE AVAILABLE | |
| 1. A Well | |
| 2. A river | |
| 3. Water Tap | |
| 4. Water Tank | |
| 5. Lake | |

7. 78 and above

LEVEL OF EDUCATION

1. No school
2. Primary
3. Secondary
4. Tertiary

EXPERIENCE IN THE AREA (YRS)

1. 0-9
2. 10-19
3. 20-29
4. 30 and above

AREA OF LAND OWNED

1. 0-5
2. 4-9
3. 10 and above

6. Pond/Dam

DISTANCE TO WATER SOURCE

1. 0-2 Km
2. 2-4 Km
3. 4 Km and above

SUSTAINABILITY OF WATER SOURCE

1. Permanent
2. Seasonal

SECTIONB: UNDERSTANDING NATURE AND TRENDS OF CLIMATE CHANGE

1. What is your household basic diet?

1. _____
2. _____
3. _____

2. Do you produce your own food?

1. Yes
2. No

3. How many meals you have per day?

1. One
2. Two
3. Three

4. Do you have this number of meals throughout a year?

1. Yes
2. No

5. Do you have enough food for the family?

1. Yes
2. No

6. Have you faced shortage of food in the past between 1988-2018?

1. Yes
2. No

7. Have you observed any changes in your environment that are potentially linked to changes you mentioned above?

1. Yes
2. No

8. For example, pasture land, agricultural land, streams/rivers?

1. Yes
2. No

9. Do you receive enough rainfall during rainy season?

1. Yes
2. No

10. If yes, to what extent?

1. Small amount of rainfall
2. Moderate rainfall
3. Enough rainfall

11. Have you observed any major changes in the rainfall and temperature in your area (village, province) over the past 30 (1988-2018)?

4. Yes
5. No

12. For how long you have observed such situation?

1. 0----5 years
2. 5----10 years
3. 10---15 years
4. 15---20 years
5. 20---25 years
6. 25---30 years
7. Above 30 years

13. What has been the situation in your area in terms of extreme climatic events like floods and droughts?

1. Moderate rainfall and temperature

2. Heavy rainfall and temperature

3. No or very little rainfall and temperature

14. Which is among the following statement describes nature of rainfall in this area:

1. Normal

2. Moderate

3. Worse

15. How would you describe the incidences of these in your area?

1. It has been declining than past years
2. It has remained the same /no changes
3. It has increased raining

16. According to your observation, how would you describe the number of rainy days in your area?

1. Have increased
2. Have decreased
3. Has been no change

17. Has the surface temperature level increased over the past 30 years in this area?

1. Yes
2. No

18. If yes, which months in a year have high surface temperature throughout?

Tick the number of the month replied from respondent

| | | |
|---|---|---|
| 1 | 5 | 9 |
| 2 | 6 | 10 |
| 3 | 7 | 11 |
| 4 | 8 | 12 |

19. Which months in the year have lowest rainfall?

Tick the number of the month replied from respondent

| | | |
|---|---|---|
| 1 | 5 | 9 |
| 2 | 6 | 10 |
| 3 | 7 | 11 |
| 4 | 8 | 12 |

SECTION C: IMPACT OF CLIMATE CHANGE ON THE HOUSEHOLD FOOD SECURITY

20 In a season, how much food/cereals do you produce?

1. Enough
2. Moderate
3. Not enough

21. In the past years, do you think your food access yields has increased, decreased or they have remained the same?

1. Has increased
2. Has decreased
3. No changes

| 22. If so, what is the reason? |
|---|
| |
| |
| |
| 23. In cases when there is no food in your household, are you able to afford buying it? |
| 1. Yes |
| 2. No |

24. Do you think the climate situation has affected your food availability?

1. Yes
2. No

25. In your view, has the food security situation in your household been affected by these climatic changes?

1. Yes
2. No

26. According to you, what weather extremes have impacted your household food security?

1. Unpredictable weather
2. Floods
3. Droughts
4. Others, including positive impacts

27. Historically (1988-2018), did you have any problems related to food that were caused by similar factors we talked about?

1. Yes
2. No

**SECTION D: PERSPECTIVE ON SEASONAL CHANGES AND CROP PRODUCTION**

28. Are there seasonal changes on crop production in this area?

1. Yes
2. No

29. If so, How?

_____

30. Do seasonal changes affect your food access?

1. Yes
2. No

31. Does the area copy with such seasonal changes?

1. Yes
2. No

32. If so, how do you copy with seasonal changes?

_____

33. How has seasonal changes affected household food security?

1. Decreased food availability
2. Increased food availability
3. Food availability remained the same

34. Do agricultural extension officers and livestock officers include climate related lessons during their field visits to your area?

1. Yes
2. No

## II: KEY INFORMANT QUESTIONNAIRE

| Name | Name: | Age | Contact details |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |

1.0 Information on climate change

1.1 What is your opinion on whether Monduli is facing or not facing climate change?

_____

1.2 Why do you say so?

_____

1.3 2If yes, how long has this been a challenge in Monduli?

_____

2.0 Household food security at the district level

2.1 How would you describe the household food security situation in the area? Do they still have enough food or not?

_____

2.2 When you look at the incomes of the households and the food prices, would you say access is sure for the households in this regard? Please explain

_____

3.0 Impacts of climate change on household food security

3.1 Has food production in the district been affected by climate change and to what extent?

_____

3.2 Can you say whether the household food security situation has been affected by climate change in this area? Explain how?

_____

3.3. What aspects of climate change have impacted food security in this area? Is it floods? Drought? Others, including positive impacts? If available, could you please provide information on magnitude of losses?

_____

3.4 According to you, how has/have the climate aspect(s) you have mentioned affected Monduli households' food security?

_____

## III: CLIMATE CHANGE OBSERVATION CHECKLIST

Name of the village: _____

1. Nature of vegetation cover

| Observable criteria | Remarks |
|---|---|
| Grasslands | |
| Affected by erosion | |
| No grass/no vegetation | |
| Area with heavy forest | |

2. Nature of water bodies

| Observable criteria | Remarks |
|---|---|
| Nature of bore holes | |
| Alternative available water sources | |
| Number of rivers flowing throughout the year | |

3. Nature of agriculture/food production/farms

| Observable criteria | Remarks |
|---|---|
| No farms | |
| Area covered by farms | |

4. Nature of area surface temperature

| Observable criteria | Remarks |
|---|---|
| Wet | |
| Warm and dry | |

5. Health of animals

| Observable criteria | Remarks |
|---|---|
| Moderate | |
| Worse | |
| Good | |

## IV: RESEARCH CLEARANCE AND PERMIT DOCUMENTS

## SECONDARY DATA APPLICATION DOCUMENT

P.O. Box 1054
Arusha
scarionr@gmail.Com
255756680081/0715
Date 13/8/2019

The director,
Arusha Airport authority
P.O. Box 512 Arusha

RE: Request for Climate data for Monduli district (1988-2018)

In order to accomplish my master's degree in Monitoring and Evaluation (MA. M&E), I must do a dissertation. I am doing my dissertation on "Climate change impact on food security in Northern Tanzania, a case of Monduli District.
Since your Airport authority deals with recording climate data for Monduli district, I here request to obtain such data from your organization.
I also attach a supportive document from my supervisor that proves my identity of being a student at Open University of Tanzania
I remain optimistic that my request will be put into high consideration
Sincerely,

Scarion Rupia

**THE OPEN UNIVERSITY OF TANZANIA**

***DIRECTORATE OF POSTGRADUATE STUDIES***

P.O. Box 23409
Dar es Salaam, Tanzania
http://www.openuniversity.ac.tz

Tel: 255-22-2668992/2668445
ext.2101
Fax: 255-22-2668759
E-mail: dpgs@out.ac.tz

**Our Ref: PG2017992301**

16th August 2019

The Director,

Monduli District Council,

P O Box 1

Arusha.

**RE: RESEARCH CLEARANCE**

The Open University of Tanzania was established by an act of Parliament No. 17 of 1992, which became operational on the 1st March 1993 by public notice No. 55 in the official Gazette. The Act was however replaced by the Open University of Tanzania charter of 2005, which became operational on 1st January 2007. In line with the Charter, the Open University of Tanzania mission is to generate and apply knowledge through research.

To facilitate and to simplify research process therefore, the act empowers the Vice Chancellor of the Open University of Tanzania to issue research clearance, on behalf of the Government of Tanzania and Tanzania Commission for Science and Technology, to both its staff and students who are doing research in Tanzania. With this brief background, the purpose of this letter is to introduce to you **Mr.RUPIA, Scarion Anatory Reg: No PG2017992301** pursuing **Master of Arts in Monitoring and Evaluation (MAME).**We here by grant this clearance to conduct a research titled ***"Climate Change Impact on Food Security".***He will collect his data at Makuyuni, Mswakini, and Esilalei wards in Arusha Region from 15th August 2019 to 31st August 2019.

In case you need any further information, kindly do not hesitate to contact the Deputy Vice Chancellor (Academic) of the Open University of Tanzania, P.O. Box 23409, Dar es Salaam. Tel:022-2-2668820.We lastly thank you in advance for your assumed cooperation and facilitation of this research academic activity.
Yours Sincerely,

Prof.Hossea Rwegoshora
**For:VICE CHANCELLOR**
**THE OPEN UNIVERSITY OF TANZANIA**

*DIRECTORATE OF POSTGRADUATE STUDIES*

P.O. Box 23409
Dar es Salaam, Tanzania
http://www.openuniversity.ac.tz

Tel: 255-22-2668992/2668445
ext.2101
Fax: 255-22-2668759
E-mail: dpgs@out.ac.tz

**Our Ref: PG2017992301**

16th August 2019

The Director,

Arusha Airport,

P O Box 502,

Arusha.

**RE: RESEARCH CLEARANCE**

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Yours Sincerely,

Prof.Hossea Rwegoshora
**For:VICE CHANCELLOR**
**THE OPEN UNIVERSITY OF TANZANIA**